Historic, archived document

Do not assume content reflects current scientific knowledge, policies, or practices.

Ag84C
[illegible]

LIBRARY
RECEIVED
★ JUN 7 1941 ★
U.S. Department of Agriculture

Circular No. 582

Avocado Diseases in Florida

By H. E. STEVENS, Senior Pathologist
and
R. B. PIPER, Scientific Aide

Division of Fruit and Vegetable Crops and Diseases
Bureau of Plant Industry

UNITED STATES DEPARTMENT OF AGRICULTURE

WASHINGTON, D. C., MAY 1941

Circular No. 582

May 1941 • Washington, D. C.

UNITED STATES DEPARTMENT OF AGRICULTURE

Avocado Diseases in Florida

By H. E. Stevens, *senior pathologist*, and R. B. Piper, *scientific aide, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry*[1]

CONTENTS

	Page
Introduction	1
Diseases of the fruit	2
Avocado scab	2
Cercospora spot or blotch	12
Black spot or anthracnose rot	21
Fruit rots	23
Diseases of the bark	28
Collar rot	28
Diseases of minor importance	29
Powdery mildew	29
Diseases of minor importance—Continued.	
Rusty blight	31
Russet fruits	32
Alga leaf spot	33
Lichen spots	33
Mechanical injury	34
Tipburn	34
Sunscald	37
Sun blotch	40
Literature cited	65

INTRODUCTION

The avocado as grown under Florida conditions is subject to attack by several parasitic diseases. Some of these are of minor importance and require no special control methods; others are more severe and require certain attention each season; still others may be largely influenced by seasonal conditions, and the severity of the attacks will depend chiefly upon prevailing weather at critical periods during the year.

The production of avocados in Florida is gradually increasing, the acreage is being expanded, and keener interest is shown in the use of suitable varieties and the production of a more marketable and profitable product. A knowledge of the diseases affecting the avocado and the adoption of methods for their control are important factors in producing the crop. The avocado tree is a rapid and vigorous grower, and it will readily return to normal condition after severe injuries due to storms, drought, or freezes. Vigorous growing trees exhibit remarkable resistance to external attacks of parasitic organisms, even though these have gained entrance into the bark. If regularly supplied with enough plant food and water the trees will generally produce satisfactory crops of fruit. Diseases, however, frequently limit the size of the crop or reduce its value to such an extent as to be unprofitable. Because profit is the ultimate aim of production, interest naturally centers on those factors that hinder the quantity and quality of production.

---

[1] During the period of these investigations helpful cooperation has been received from avocado growers, county agents, and various members of the staff of the Department of Agriculture, and due acknowledgment is made for the helpful advice and assistance, which have aided materially in the successful progress of the field and investigational work. In field cooperation Mr. H. E. Schaff and Mrs. W. J. Krome, of Homestead, Fla.; Mr. Ivey Futch, of Lake Placid, Fla.; and Mr. W. F. Ward, of Avon Park, Fla., have rendered valuable help in furnishing bearing avocado trees for the experimental spray tests. Credit is also due Mr. Charles H. Steffani, county agent of Dade County, and Mr. J. R. Brooks, of Homestead, for assistance in carrying out the annual spray programs. Various members of the staff of the Division of Fruit and Vegetable Crops and Diseases have assisted in the laboratory and field work from time to time, and due appreciation is given for their able help. Messrs. H. R. Fulton, F. J. Wooten, and J. W. Bowman, of the Division of Fruit and Vegetable Crops and Diseases, have materially aided in the progress of the work. The illustrations are all from originals made by Mr. Piper. Full appreciation is given to Dr. E. C. Auchter, chief of the Bureau of Plant Industry, and Dr. H. P. Traub, of the Division of Fruit and Vegetable Crops and Diseases, for their keen interest and helpful suggestions and support in carrying through the projects.

The purpose of this circular is to bring together all the practical information available on diseases that are likely to occur on the avocado in Florida. The use of this information should aid growers in materially reducing the annual loss to trees and fruits resulting from the attacks of several widespread and well-known diseases.

The information presented herein deals chiefly with the fruit and foliage diseases, and it is based mainly on the results of studies and experimental tests made in avocado groves in different sections of the State during the past 6 years. Other sources have been drawn upon in compiling a list of the diseases and in making comparisons with avocado diseases in other parts of the country.

For convenience the diseases may be classed under three groups—diseases of the fruits, diseases of the bark, and minor diseases affecting various parts of the plant.

DISEASES OF THE FRUIT

In general, fruit diseases are responsible for the largest amount of loss to the avocado growers in Florida. Foliage diseases and those affecting the trunk, roots, and branches are of secondary importance in the matter of crop production, and these ordinarily are given very little attention.

Under Florida conditions several diseases occur on avocado fruits. Those most commonly observed and widely distributed over the State are scab, cercospora spot or blotch, and black spot. Of less importance are decays following maturity of the fruit, which are observed less frequently in the field than on the markets. All of these diseases are of fungus origin and most of them can be controlled by proper spraying procedure.

Avocado scab and cercospora spot cause the greatest damage to avocado fruits, and these diseases are found in practically all localities in the State where avocados are grown.

AVOCADO SCAB (SPHACELOMA PERSEAE) Jenkins

Avocado scab is a parasitic disease that may severely affect the fruits, young shoots, and leaves of certain varieties of avocados grown in Florida. The disease was first reported in the State in 1918 (*8*)[2] as a severe pest in avocado nurseries. It has since spread generally throughout the State, and at present avocado scab may be found in the commercial plantings in any locality where susceptible varieties are present.

---

[2] Italic numbers in parentheses refer to Literature Cited, p. 45.

Under certain seasonal conditions the disease may cause severe injury to the foliage of bearing trees, but the largest percentage of loss usually results from attacks of scab on fruits. Where highly susceptible varieties are concerned a seasonal attack of scab may affect 100 percent of the fruits on the trees, varying from slight infections to very severe. Out of such fruits probably 90 to 100 percent would be classed as low-grade fruits, the larger portion of which would be unsalable. Although the injury is confined to the outer surface and does not materially affect the quality of a mature fruit, it mars the outward appearance, resulting in lower grades and dwarfed or misshapen fruits that rate as culls. Severe attacks during the period the fruit is setting cause a heavy dropping of affected fruits, further adding to the loss in yield.

VARIETIES AFFECTED

Although scab is widely scattered over the State it does not seriously affect all avocado varieties. In general, varieties of the West Indian, Guatemalan, and West Indian-Guatemalan hybrid races seem to be more susceptible to scab under Florida conditions than varieties of the Mexican type. The Mexican race has very little in its favor for use in commercial production in Florida, but this natural tendency toward scab resistance may make it a valuable adjunct in breeding scab-resistant strains of avocados.

However, there is a great variation in the susceptibility of varieties to scab, in each of the three races. Some of the West Indian seedlings are severely attacked; others of the same race are highly resistant or practically immune.

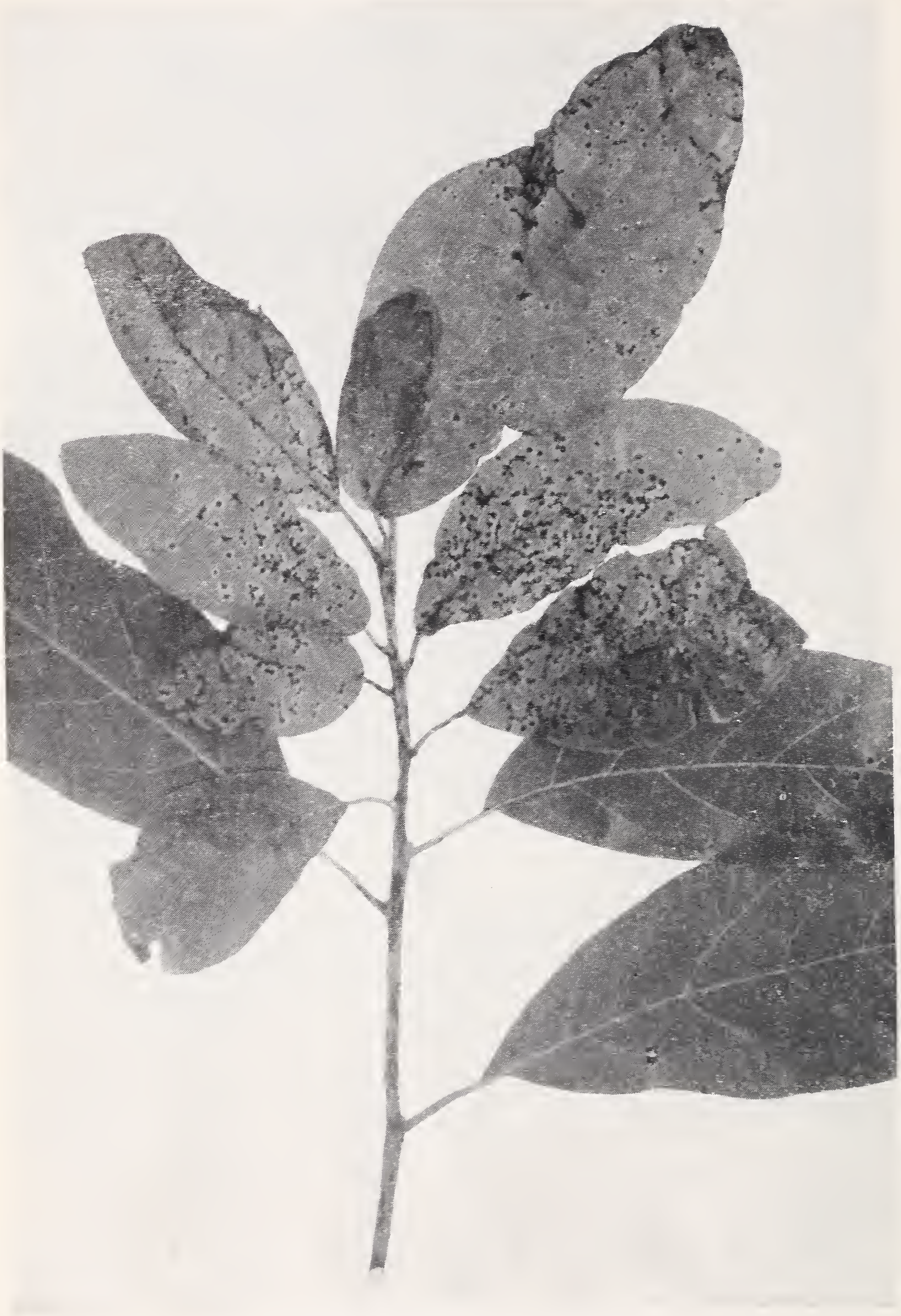
Of the commercial varieties grown in Florida, the Lula is most severely affected by scab, with the exception of individual plants of West Indian seedlings. In any location in the State where the Lula is grown it is generally severely attacked by scab on both fruit and foliage. The Winslowson, Taft, Fuerte, Taylor, Nabal, Trapp, Eagle Rock, and McDonald are also subject to scab in a descending degree of susceptibility, about in the order named.

Varieties that are highly resistant and only slightly affected by scab are Pollock, Collinson, Waldin, Collins, and Gottfried. These varieties ordinarily require no special control measures for scab prevention on the fruit.

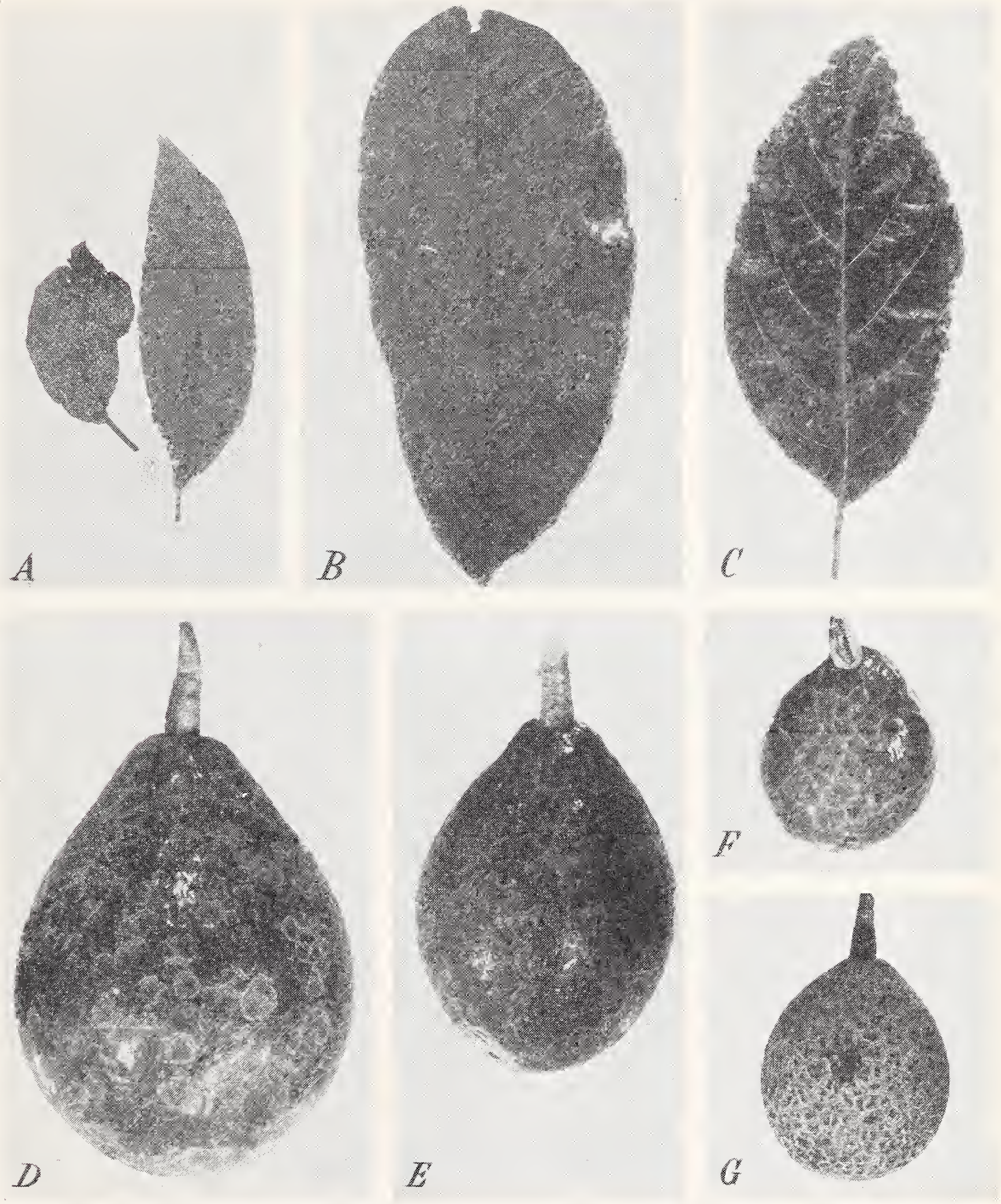
Some of the newer varieties that have been more recently introduced into the trade have not been under observation long enough for classification as to scab resistance.

APPEARANCE

Avocado scab is observed as definite spots or patches on the leaves, young shoots, and fruits of various avocado varieties (pls. 1 and 2). The scab spots may be scattered or numerous, and severe attacks may cause a curling of leaves and a distortion of twigs and fruits. Individual spots are generally small, circular to irregular in outline. varying from one-sixteenth to three-sixteenths of an inch in



Scab on young twig of avocado.



Various stages of scab on avocado leaves and fruits. *A*, Scab on young leaves, scattering spots, and severe infection distorting leaves. *B*, Severe scab on more mature leaf. *C*, Old weathered spots on fully matured leaf. The fungus is carried over from one season to another in such spots. *D*, Typical scab spots on matured fruit, showing raised and cracked surface. *E*, Old and new scab spots on the same fruit; small spots represent a later period of infection. *F*, Fruit severely affected with scab when small, illustrating the stunted character of growth. *G*, Russet condition of surface due to severe attack of scab on young fruits.

diameter. They are purplish brown to dark brown in color, fading to a lighter brown with age. The spots penetrate the leaf tissue and become visible on both sides of the leaf, in which case the under side of the spot may be bulged outward and marked by a purple discoloration. The centers of the older leaf spots are composed of dry, dead tissue, more or less spongy, and light brown in color. In time the centers of the spots may fall away, leaving small holes in the leaf, which are fringed with a narrow border of the epidermal layers, white to grayish in color (pl. 2, *C*). Spore production may occur repeatedly on either surface of these spots under suitable moisture and temperature conditions.

On the leaf petioles and the green bark of shoots and twigs the spots are more elevated, a darker purple in color, with comparatively smooth surfaces. They are oval to elongated in shape, and in general outline may resemble one of the soft scale insects.

On fruits the same oval-shaped, raised type of spot is found that occurs on twigs. In light infections the spots may be small and scattered; in severe ones the spots may combine, forming irregular areas of hard glazed tissue involving most of the surface of the fruit. These areas are dark brown in color, and as the fruits increase in size the surfaces of such areas become marked with fissures or cracks (pl. 2, *D*, *E*, *F*, and *G*). The spots are confined chiefly to the outer surface and do not penetrate through the rind of the fruit; however, through the cracks and fissures in old scab spots other rot-inducing fungi frequently enter the flesh, causing decay in the mature fruits. Black spot frequently follows scab infections as a secondary trouble.

CAUSE

The disease is caused by a fungus which has been identified as *Sphaceloma perseae* Jenkins (*4*). This fungus is capable of entering the young succulent tissue of avocado foliage and fruits, forming definite spots or areas in which it grows and produces spores. From these centers the disease is spread to other parts of the tree or to other trees in drops of rain or dew-drip, by insect carriers, or by wind. It is carried over from one season to another by infections on leaves.

Avocado scab is very similar to citrus scab in its general appearance and in the reaction of its host. When first reported (*8*) it was considered a variant of the citrus scab fungus, which was designated at that time as *Cladosporium citri* Mass. Later Jenkins (*5*, *6*) reclassified the citrus scab organism placing it in the genus *Sphaceloma*, and recognized the avocado scab organism as a distinct species, *Sphaceloma perseae*. There are certain fundamental differences between the two organisms, and her description and use of the new name for the avocado scab fungus appears to be valid.

The infectious nature of the disease has been proved conclusively by numerous inoculation experiments over a period of several years, in which pure cultural strains of the fungus were applied to susceptible tissue of the avocado, including leaves, stems, and fruits. Lesions appear as small watery dots on the surface in from 7 to 10 days after the inoculations are made, and these later develop into the typical spots or areas characteristic of avocado scab. In these spots numerous spores are produced which continue the spread of infections as long as susceptible tissue is available and weather conditions are favorable.

INFECTION AND SPREAD

The development and spread of scab depends chiefly upon weather conditions at the time new growth is appearing and during the early period of the growth of the fruit. The fungus is most active in cool, moist weather. Under such conditions spores are produced abundantly in the hold-over spots and areas on old leaves. In the case of foliage only the young, tender leaves are attacked, and as soon as the leaf tissue hardens the fungus is unable to cause further infection. This critical period for leaf infection is probably a month or less in duration, and is much shorter than that for fruits. If the spores come in contact with susceptible tissue in the presence of sufficient moisture, infection may take place in a few hours. Thus a heavy rain during the period when the fruit and foliage are most susceptible may cause a severe attack of scab, if followed by cool, cloudy weather for 24 hours. Extended periods of fog or heavy dews may cause the same result. The infections from such an attack would not be evident until a week or 10 days later.

On the fruits the period for infection is much longer and may extend over several weeks. Young fruits may be affected by scab from the time the petals fall until they have attained a third or half of their normal development. Consequently early and late infections are frequently found on the same fruit (pl. 2, *E*), when the period favorable for scab development has been of long duration. In certain seasons the opening of bloom and setting of fruits are very irregular, and a period of 2 months may elapse between the opening of the first and last flowers. This gives an irregular set of fruits, of various ages, and extends the possibility of fruit infection over a much longer time. Scab sometimes develops on the flower stems in the bloom panicles before the flowers open. Such infections are very effective sources for spreading the disease, as they are in close proximity to the young developing fruit.

If the weather is dry and warm during the period of bloom and fruit setting, very little scab may appear on the fruit even though the leaves of the trees show an abundance of old scab infections. On the other hand, under weather conditions favorable for scab development the fruits may be severely affected when only a scattering of infected old leaves are present to start the disease.

SPRAYING EXPERIMENTS

During the past 6 years field-spraying experiments have been conducted for avocado scab control in a commercial grove at Lake Placid, Fla., on the Lula variety, which is very subject to scab both on fruits and foliage. The purpose has been to work out a practical spray schedule for avocado scab control that could be applied generally by growers throughout the State. During four of the six spraying seasons scab appeared abundantly on the trees, affording a good test for the efficiency of the spray used and the different schedules followed.

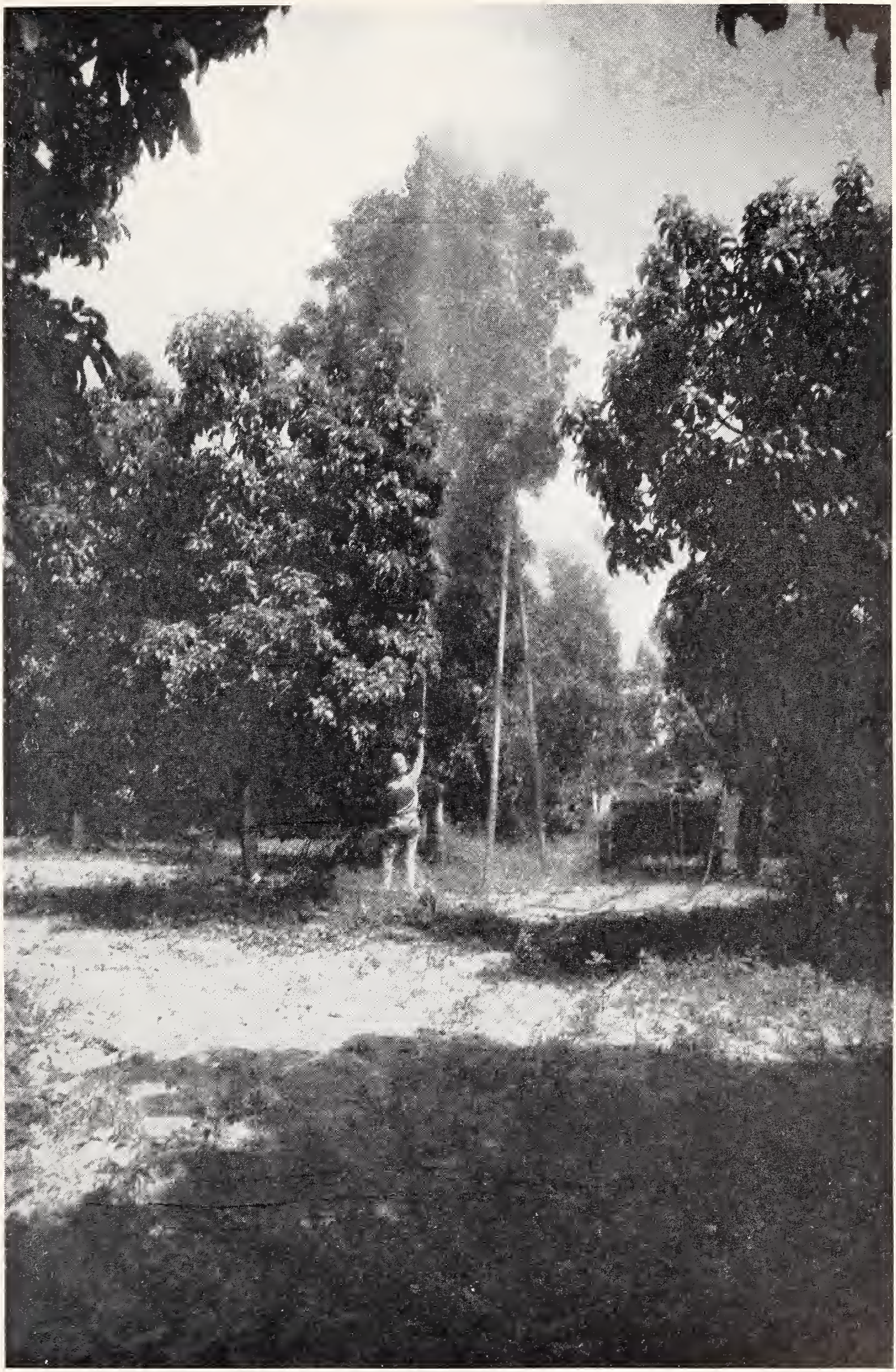
In these experiments 3-3-50 bordeaux mixture freshly prepared in the field was used. Calcium caseinate was added to the spray solutions at the rate of 2 pounds to each 200 or 300 gallons of spray material. The spray was applied with guns from a power sprayer at a pressure of 360 to 400 pounds, with a thoroughness comparable to the best commercial practice. Many of the avocado trees were tall and slender in habit of growth reaching a height of 40 to 50 feet, and it was only by means of a good spray gun and high pressure that the tops of such trees could be thoroughly sprayed (pl. 3).

The full program followed included a dormant spray as the first application; a second, or bloom spray, near the end of the bloom; a third application from 2 to 4 weeks after the bloom spray; and a fourth and a fifth application, following the third, at monthly intervals. The number of applications was varied for the different plots and during the several seasons, as indicated in table 1, which gives the spray programs followed and summarizes the results for 4 seasons when scab was prevalent.

TABLE 1.—*A summary of the spraying experiments for avocado scab control during 4 seasons at Lake Placid, Fla.*

Season and plot No.	Application	Date of spray application						Fruit infection		
		January	February	March	April	May	June	None	Slightly infected	Heavily infected
1933 season:	*Number*							*Percent*	*Percent*	*Percent*
1	2		3	31				14.4	20.9	64.3
2	3		3	31		2		23.0	23.2	53.2
3	2			31		2		1.1	14.5	84.3
4	1			31				1.6	5.4	92.8
5	None							.0	.0	100.0
1934 season:										
1	None							.0	2.0	98.0
2	4		9		20	4, 18		69.6	16.2	14.2
3	3		9		20	4		61.3	16.6	22.1
4	3		9		20	18		30.0	31.0	39.0
5	3				20	4, 18		21.0	31.4	47.4
6	2				20	18		1.6	17.4	81.0
7	None							1.4	7.4	91.2
1936 season:										
1	None							1.6	4.1	94.3
2	5	28	27	25	16	19		97.0	2.2	.8
3	4	28	27	25	16			96.2	2.8	.9
4	4	28	27	25		19		83.2	11.7	4.9
5	4	28	27		16	19		91.8	6.4	1.8
6	4	28	27	25	16	19		98.0	2.0	.0
7	4		27	25	16	19		71.0	16.3	12.7
1937 season:										
1	None							1.4	2.8	95.8
2	5	19		17	15	17	15	87.5	5.4	7.3
3	4	19		17	15	17		89.0	3.4	8.0
4	4	19		17	15		15	74.9	10.5	14.4
5	4	19			15	17	15	19.9	17.1	63.3
6	3	19			15	17		19.1	16.2	64.7
7	3	19			15		15	12.7	18.9	68.4

In arriving at the percentage of scab-infected fruits in the experimental plots, from 500 to 1,000 fruits on each plot were observed and classified as infected or free from infection. The infected fruits were graded as very slight, two to six small spots per fruit; slight, a dozen or more spots per fruit; medium, when about one-half the surface was involved with small scattered spots; severe, where three-fourths of surface was involved, or large scattered patches of scab were present; and very severe, everything beyond severe. As com-



Spraying the tops of tall avocado trees with a spray gun.

pared with commercial grading, very slight and slight (slightly infected in table 1) would fall in commercial grade No. 2; and medium to very severe (heavily infected) in grade No. 3 and culls. The fruits were checked when they were nearing maturity and before the first harvest date. The avocado crop is not harvested all at one time; successive pickings may be required to complete the harvest of the crop. Because it was not practicable to view the entire crop on any plot except by observing and counting the fruits on individual trees, this plan was followed throughout the experiment in classifying the fruit. As the same person counted and classified the fruits on the various plots each year, the resulting data can be considered fairly consistent.

Evidently in 1933 and 1934 the spray applications were too few to control scab under the prevailing conditions. Scab was abundant and active for a long period during both of these seasons and fruits were infected early and late. The omission of the dormant application resulted in a considerable build-up in scab in both seasons. Spraying was omitted during the 1935 season because the trees were recovering from injury due to low temperatures a few weeks before and no crop was set.

The 1936 program indicates the value of a dormant spray and of more continuous protection of the young fruit. Omission of the dormant application resulted in greater increase in scab infection than did the omission of any one of the other applications. Opening bloom appeared early in February and continued through March. The critical period for infection extended from February until late May, but the peak of infection appeared during the early part of this period, and the fifth application had little effect.

In 1937 the dormant application was made on all plots, but the bloom application was omitted on several. A very decided increase in scab infection occurred where the bloom spray was omitted. Four and five successive applications of spray gave about the same control. Opening bloom appeared in late February and continued into early April, extending the infection period for fruits well into the month of May. The peak of infection again appeared during the early part of the critical infection period, as is indicated by the large increase in scab infection where the bloom application was omitted and by the apparent ineffectiveness of the June application.

Attacks of avocado scab on fruits may be kept under satisfactory control if spray applications are made at the proper time. Weather conditions at the time the avocado tree is blooming and the fruit setting will largely determine the number of spray applications required for control, and no set spray schedule in regard to the number and time of applications will apply for all seasons or for all sections of the State. Under the most favorable conditions for scab infection the young, developing fruit is probably susceptible for a period of 2 months or more from the time the petals fall, and two or three applications may be necessary for full protection during this time. An irregular or prolonged bloom may extend the time in which some of the fruits may become infected for a longer period, as a few early fruits may appear before the main part of the crop has set and still others following the main crop. However, extra spray applications to protect these fruits would hardly be justified. The spraying operations should be planned with the object of protecting the largest percentage of the crop with a minimum number of spray applications.

The results during the past few years have indicated that 3–3–50 bordeaux mixture will readily control scab, and that four or five applications will be necessary for good commercial control in seasons when scab is severe. However, it is not practical to conform to any set schedule or spray program that can be generally used season after season. Although three well-timed spray applications may give satisfactory protection from avocado scab during a particular season, five applications may be required the next year to give the same protection. This may be due entirely to weather conditions, which are the determining factors in the development and spread of scab during the period of open bloom and setting of fruits, or to a late or prolonged bloom which requires more protection than one that appears early or is of short duration. Under Florida conditions several of the varieties regularly require some spraying for scab control to insure a crop of first-grade fruit.

Spraying for avocado scab is merely a system of protection and to be effective it must be made in advance of the injury. After the crop is infected it is too late to accomplish much through spraying, and more may be lost than gained where sprays are applied too late.

The best spray schedule for any particular grove will depend largely upon conditions affecting that grove during the season, and each individual grower will have to determine these for himself. As a guide, a suggested spray schedule or program is offered. It is based on field studies of avocado scab and spraying experiments for scab control during the past 6 years.

It has been planned to control scab under the most severe conditions, and it suggests more applications than would probably be necessary during the average season. It can be modified, however, to suit the conditions during a particular season, and if judiciously followed the loss from scab can be reduced to a very small percentage of the crop.

SPRAY SCHEDULE FOR SCAB

Spray	*Application*
3–3–50 bordeaux mixture	No. 1. Dormant spray. Just before or immediately after the bloom buds appear.
	No. 2. Bloom spray. Near end of bloom period when small fruits are visible.
	No. 3. After the bloom period ends, from 2 to 4 weeks after No. 2.
	No. 4. 3 to 4 weeks after No. 3.
	No. 5. 1 month after No. 4.

The spray applications should be thorough and applied as a uniform covering over the foliage and fruits. Tall trees will require a pressure of 360 to 400 pounds and the use of a good spray gun to cover the tops where the heaviest infections sometimes occur (pl. 3).

The dormant application is necessary on very susceptible varieties and is applied just before or as the bloom buds are bursting. The purpose of this application is to cover the old infected leaves and twigs thoroughly with a coating of bordeaux mixture. This will prevent the formation and spread of spores from old scab spots that have carried the fungus over from the past season. Also, it will prevent the early establishment of the fungus on much of the new foliage and fruit buds early in the season, reducing the chances for early infection on newly set fruits.

The second application of bordeaux mixture, or bloom spray, should follow near the end of the bloom period or when the major portion of the flowers have opened and the fruit is setting. It is important that the smaller fruits receive early protection, because more serious losses occur from infections on very small fruits than on those that are larger. A heavy infection on fruits the size of a pea or smaller will cause a greater reduction in the crop than the same intensity of infection a month or 6 weeks later. A large percentage of severely infected small fruits will drop, and those that remain will be reduced in size and lowered in grade. The bloom spray is important in protecting the fruits over a period when they are most susceptible to infection.

If conditions are favorable for scab development, such as rains, cloudy weather, and cool temperatures, a third application of 3–3–50 bordeaux mixture should be made in 2 or 3 weeks after the bloom spray. The fourth and fifth applications should follow at monthly intervals.

If the weather is warm and dry following the bloom spray the third, fourth, and fifth applications may be made at monthly intervals. It is believed that three or four applications will control the disease sufficiently under most conditions, and it is only in those seasons when cool, rainy weather continues through the spring months that the fourth and fifth applications will be required. There is frequently a period of 6 to 8 weeks between the dormant or No. 1 application and the bloom or No. 2 application. This may be due to a late bloom or a prolonged-bloom period, and fruits set from such blooms may be exposed to infection later in the season than fruits set from a normal bloom. Rains generally occur in late April and through May, and a fifth application may be needed to protect the fruits through June.

It should be remembered that avocado scab and wet weather are closely associated, and the spray schedule should be planned accordingly.

CERCOSPORA SPOT OR BLOTCH (*CERCOSPORA PURPUREA*) COOKE

Cercospora spot or blotch is more prevalent in Florida than avocado scab, as it occurs on practically all varieties of importance, and probably causes greater damage to avocado fruits than any other single disease affecting the crop. It is a fungus disease and was first reported from southern Florida along the lower east coast as severely affecting the fruits of the West Indian seedling avocados (*9*). The disease soon appeared on the commercial varieties and has spread to all parts of the State where the avocado is grown. It is often confused with colletotrichum black spot, with which it is generally associated, but the two diseases are distinctly different.

Cercospora spot usually appears on the fruit sometime in advance of black spot, and it also affects the leaves and stems of the fruit. Attacks of the disease on fruits are confined to the rind, which becomes severely spotted or marred by cracks, and these indirectly open the way for other organisms to enter and cause decay of the flesh. The *Cercospora* fungus itself causes no decay of the interior flesh of fruits. The disease is annually responsible for a large percentage of low-grade fruit, and severe attacks may render the greater part of the crop unprofitable to handle. Such losses can be readily avoided by proper methods of spraying, as cercospora spot is more easily controlled than avocado scab if precautions are taken in time.

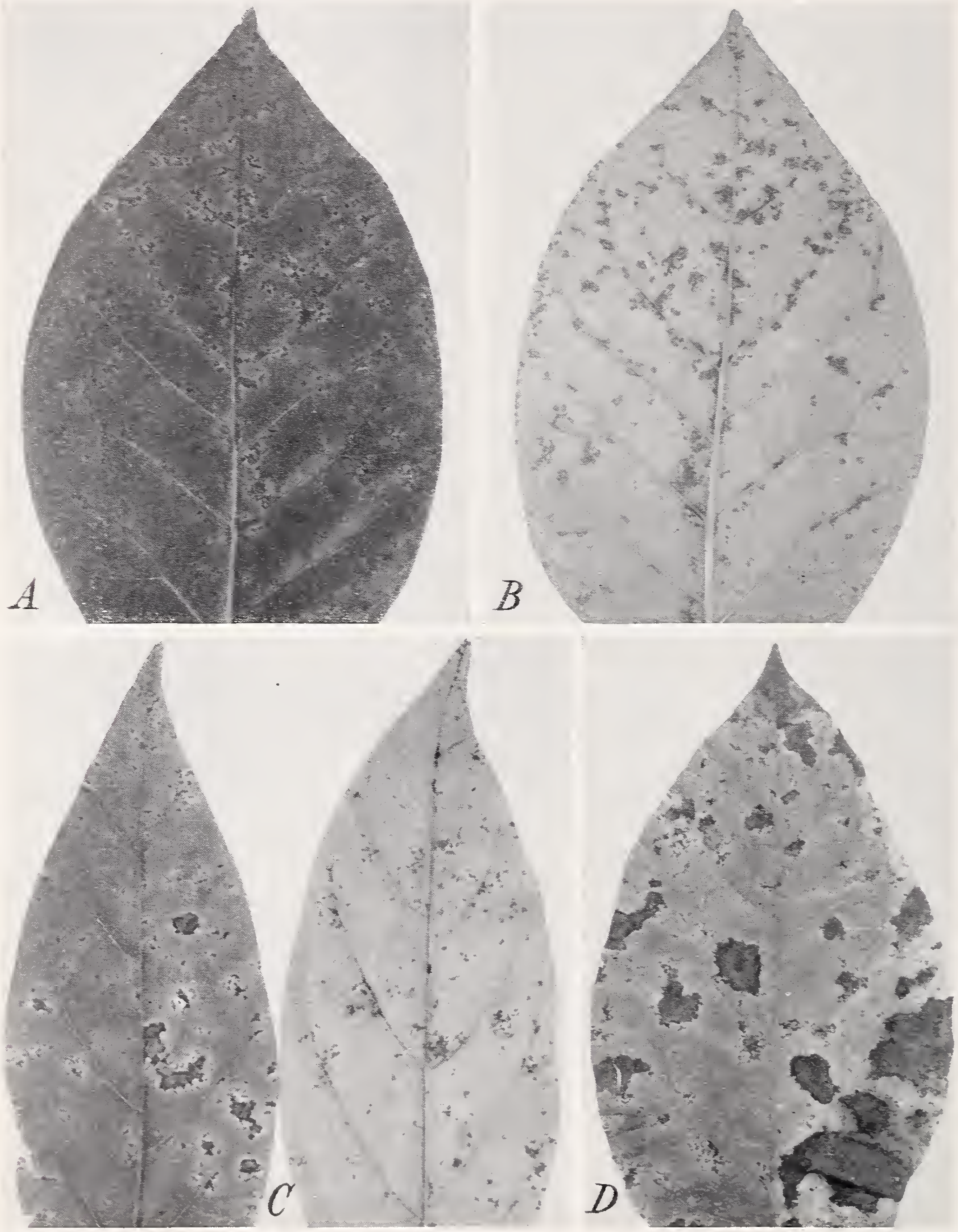
VARIETIES AFFECTED

Infections have been found on the fruits and leaves of practically all varieties grown in Florida, and none seems to be definitely immune or highly resistant as are certain varieties to avocado scab. When the disease becomes well established in a grove it severely affects the Fuerte, Waldin, Winslowson, Trapp, Lula, Wagner, Taylor, Nabal, Pollock, Eagle Rock, and West Indian seedlings. A variety may appear slightly affected one season and become severely affected the next if favorable conditions for the development of the disease occur; or a variety may appear highly resistant for several seasons, requiring no special spray treatment, and later becomes severely infected after the fungus has become firmly established in the trees.

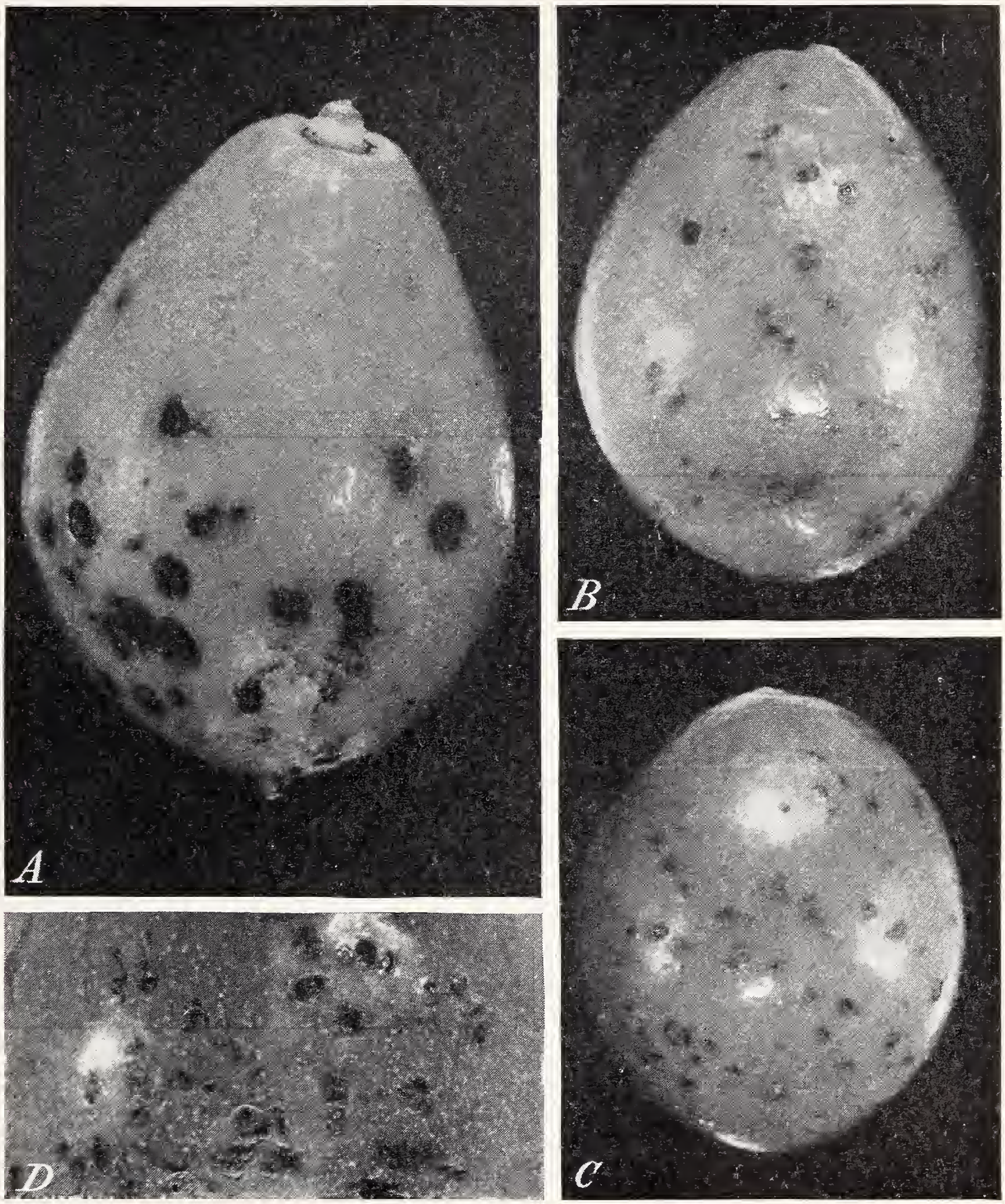
APPEARANCE

Cercospora spot is a fungus disease that appears on the fruits, fruit stems, leaves, and occasionally on young shoots of avocado trees (pls. 4 and 5). It differs from scab in that it does not attack the young, tender, growing tissue until it has reached a certain stage of maturity. Characteristic spots are formed on fruits and leaves by which the disease is easily recognized. It is entirely different from scab in appearance and in the general effect upon the parts attacked. The spots are generally scattered, distinct, and definite in outline (pl. 4, *A*, *B*, and *D*). It causes no shedding of bloom or young fruits, as infections do not occur until several weeks after the fruits have set. The disease is apparently carried over from one season to another through infections on leaves.

The fungus produces small brown to dark-brown angular spots on the leaves. These first appear on the under surface of the leaves as slightly raised, blisterlike swellings, purplish in color and not visible from the upper side of the leaf. Later the affected area turns brown, the tissue collapses, and the spot has a sunken appearance visible on both surfaces of the leaf. Soon spore-bearing tufts of the fungus emerge from both sides of the spot, forming a grayish tinge over the surfaces. The spots may be scattered over the leaf and distinct, or several spots may be grouped together in the vein angles or along the midrib, forming irregular brown patches of dead tissue. Under moist conditions spores are produced in succession on these dead spots during the season.



Various stages of cercospora spots on avocado leaves. *A*, Typical cercospora spots on the upper surface of a mature leaf. These spots bear only the conidial type of spore. *B*, Under surface of the same leaf, showing the spots penetrating the leaf tissue. *C*, Upper and under surfaces of more mature leaves, showing the small angular spot, which is conidia bearing, and larger dead areas in which perithecia of *Mycosphaerella* are found. *D*, An old and fully matured leaf with numerous large dead areas in which perithecia are borne. This type of infection may carry the fungus over long periods unfavorable for conidia development.



Various stages of cercospora spots on avocado fruits. *A,* Mature Waldin avocado, showing a medium infection of typical cercospora spots of advanced stages. *B,* Initial stages of cercospora infection showing as small raised bumps. A few larger spots are more advanced. *C,* A later stage in the development of the spots. *D,* An enlarged view of a group of cercospora spots on the rind of the fruit, showing relative size, shape, and cracked or fissured surfaces of spots. × about 3.

Spots on the fruit appear as small greenish-white dots which later develop into slightly sunken, irregular surface blotches. These are usually brown to dark brown in color, and short, gray tufts of fungus growth bearing spores soon appear on their surfaces. The spots may increase in size and finally develop into circular areas of hard brown dead tissue the surfaces of which become cracked or fissured. Mature spots vary in size from one-eighth to one-fourth of an inch in diameter. Spots frequently occur in groups on the surface of the fruit or coalesce, forming irregular areas of dead rind tissue deeply fissured by surface cracks (pl. 5). The activity of the fungus is confined to the outer surface of the rind tissue, and it does not enter or affect the flesh of the fruit directly. However, through cracks in the surface of spots and fissures in the larger areas of dead rind tissue other fungi enter that cause the fruit to decay. These are probably the main sources of entry for black spot, which consistently follows attacks of cercospora spot on fruits.

CAUSE

The disease is caused by a fungus belonging to the *Cercospora* group, probably *Cercospora purpurea* Cooke, which has been reported as occurring on leaves of the avocado.

The fungus has been obtained repeatedly in pure cultures from typical cercospora spots on fruits, fruit stems, and leaves, and in all cases the strains isolated have appeared to be identical. The infectious nature of the fungus has been definitely established by numerous inoculations on healthy-growing avocado fruits, and typical spots of the disease have been reproduced. Infected leaves are the principal sources of continuing the disease in the tree year after year, and infections on fruits come primarily from the infected leaves. A perfect stage has occasionally been found associated with the fungus in the larger dead spots on old, matured leaves (pl. 4, *C* and *D*). The identity of this form has not been definitely established yet, but it appears to be a species of *Mycosphaerella.* This form has a different type of spore from the *Cercospora* type, and it probably serves to carry the fungus through periods less favorable for its normal development. Inoculations with pure-strain cultures from this mycosphaerellalike form have also produced typical cercospora spots on fruits; however, the natural infections on fruits result chiefly from the *Cercospora* type of spore which appears abundantly on the spots on leaves throughout the summer season. Spores are produced abundantly during periods of warm, rainy weather, and they may be distributed over long distances by wind and insects and through the individual trees in drops of rain and excessive dew.

The fungus is highly parasitic to the rind of the avocado during a certain stage in the growth of the fruit. Young fruits and those that are nearly mature are practically immune to the fungus, but during the period between, infections may readily occur if the spores and sufficient moisture for spore germination are present at the same time. The critical period for fruit infection is probably during the time it is one-fourth to three-fourths mature. The period of heaviest spore production usually occurs from the middle of May to late August, and this corresponds to the time during which the fruits are most seriously infected.

Inoculations have shown that it requires from 30 to 40 days after the fungus has entered the rind for any outward effects to be visible, and 10 to 15 days more for the spots to become fully formed and produce spores. Secondary infections may appear on the same fruit late in the season after the fruit has reached its stage of apparent immunity.

Inoculations made through June and early July reacted more quickly and in greater numbers than inoculations made earlier or later in the season.

It is not possible at present to set the limits of susceptibility for the avocado fruit between definite dates or to restrict them to certain sizes of fruit. However, there is apparently a period in the development of each fruit when it is very susceptible to infection, and this generally occurs between May 1 and August 1 with the varieties studied and under Florida conditions.

CONTROL

Spraying experiments for the control of cercospora spot have been in progress in different sections of Florida during the past 6 years. Several of the commercial varieties of avocados have been included in these tests. The spraying has been done mostly in commercial plantings and has approximated practical spray practices as nearly as possible. The purpose of these experiments has been to work out a practical and economical spray schedule that might apply to any section of the State and include any variety of avocado concerned.

The results have been encouraging, even though storms, low temperatures, and failure of fruits to set have interfered materially with the work several times during this period. It is believed that the spray schedule recommended, if consistently followed, will eliminate or greatly reduce the damage from cercospora spot and black spot that is apt to occur during any normal season.

Bordeaux mixture, 4–4–50, was the principal spray used in all of these experiments, as it had given satisfactory results in past experiments. The spray solutions were freshly prepared for each application, using powdered quicklime and finely powdered bluestone because these materials were quickly and easily handled under field conditions. Calcium caseinate was added as a spreader at the rate of 1 pound to each 100 gallons of spray solution. The spray was applied with spray guns from a power sprayer at a pressure of 360 to 400 pounds. In applying the spray the chief object was coverage of fruits rather than foliage and branches, and thorough applications were made.

In the preliminary trials one, two, and three applications were made at monthly intervals to various plots, covering the period from May through August.

As the young avocado fruits are highly resistant to cercospora spot until they have attained considerable size, it was considered unnecessary to do any spraying for the protection of the fruit previous to May 1. In the spray program that followed, all of the first applications were made each season between May 6 and May 15, succeeding applications following about 30 days apart until three applications had been made to the different sets of plots.

Table 2 gives the plan of the experiment and results obtained on Waldin avocados at Homestead, Fla., during the season of 1933. The Waldin is very susceptible to cercospora spotting, and it is one of the early shipping varieties, maturing in late September and through October. The data presented in table 2 illustrate the spray plan followed in all the other experiments except for slight variations in the number of applications and the interval of time between applications. Plots 2, 3, 4, and 9, 10, 11 are duplicate series starting May 10; and 5, 6, 7, and 12, 13, 14 are duplicate series starting June 9.

Bordeaux mixture, 4–4–50, plus calcium caseinate, was used for each spray application, and the spray dates were as follows: May 10, June 9, July 11, and August 9. The plots were checked over September 9 and 12 and fruit graded as to condition in regard to cercospora spot and black spot infections. The percentages are shown in table 2.

TABLE 2.—*Control of cercospora spot and black spot on fruits of Waldin avocados at Homestead, Fla., 1933*

Plot No.	Time of spraying	Fruit infection		
		None	Slightly infected	Heavily infected
		Percent	*Percent*	*Percent*
1	Unsprayed check	2.4	7.5	90.1
2	May	58.2	32.7	9.1
3	May, June	73.9	25.2	.9
4	May, June, July	88.8	10.6	.6
5	June	17.0	65.4	17.6
6	June, July	26.2	69.9	3.9
7	June, July, August	36.9	61.4	1.7
8	Unsprayed check	.0	10.5	89.5
9	May	60.1	39.2	.7
10	May, June	84.2	15.8	.0
11	May, June, July	85.6	14.4	.0
12	June	22.1	62.2	15.7
13	June, July	21.5	63.8	14.7
14	June, July, August	14.7	57.7	27.6

It is evident that one spray application during the season was not sufficient for satisfactory control, and that when the first application was delayed until June a decided increase of spotting occurred even on plots receiving the three applications.

The results of the various spraying experiments indicate that cercospora infections for the Waldin begin around the first of May and continue until the fruit approaches maturity. Thus the critical period during which the fruit may become severely infected extends from May 1 to probably August 1, the peak of the infection coming in late May and through June. This seems to hold true with the late-maturing varieties also and very little was gained by applications made in September or October. Applications made in May, June, and July on late-maturing varieties gave good control of cercospora and black spot and provided sufficient protection to carry the fruit to the time of harvest without further sprayings as far as these diseases were concerned.

Cercospora spot severely affects the fruit stems of several varieties and becomes particularly severe on the stems of Wagner, Winslowson, and Fuerte. These infections sometimes precede those on the fruit by several weeks, and spore-bearing lesions may occur on the stems long before the fruit is susceptible to infection. These spots or areas greatly weaken the stem if it is long and slender, as in the Wagner and Fuerte varieties, and as the fruit increases in size it is more subject to droppage, especially in the late summer when high winds prevail. Fruits with short, thick stems are not so subject to droppage even though the stems are badly affected. Where stem infections are responsible for late dropping of the fruits, an application of bordeaux mixture in early March before the regular applications will generally eliminate most of this trouble.

In a majority of these experiments two applications of 4–4–50 bordeaux mixture, applied in May and June at monthly intervals, have given almost as good control of cercospora spot and black spot as the three applications applied similarly in May, June, and July. In table 3 a comparison is given of the percentages of fruits free from cercospora spot from plots that were unsprayed and those that received two and three applications, in relation to the varieties treated and the seasons in which the sprayings were made. The two applications were applied at monthly intervals in May and June, and the three applications in May, June, and July on corresponding dates.

TABLE 3.—*Avocado cercospora spot and black spot control; a comparison of results obtained during 4 seasons with no spraying and with 2 and 3 applications of bordeaux mixture*

[The percentage indicates the proportion of uninfected fruits under each treatment]

Variety	1932 applications			1933 applications			1934 applications			1937 applications		
	None	2	3	None	2	3	None	2	3	None	2	3
	Pct.	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*	*Pct.*
Waldin	0. 6	79. 4	95. 2	1. 4	79. 0	87. 2	0. 0	93. 8	96. 4	------	------	------
Winslowson	31. 1	50. 9	63. 9	. 0	44. 7	88. 7	. 0	92. 2	95. 9	------	------	------
Wagner	------	------	------	------	------	------	36. 3	100. 0	100. 0	------	------	------
Linda	------	------	------	------	------	------	37. 5	100. 0	100. 0	------	------	------
Winslowson	------	------	------	------	------	------	6. 9	96. 1	97. 8	0. 5	75. 9	85. 7
Eagle Rock	------	------	------	------	------	------	9. 0	77. 7	96. 8	------	------	------
Taylor	------	------	------	------	------	------	------	------	------	(1)	96. 0	100. 0
Spinks	------	------	------	26. 9	93. 7	96. 7	------	------	------	------	------	------
Nabal	------	------	------	------	------	------	------	------	------	5. 2	99. 8	100. 0
Collinson	------	------	------	------	------	------	------	------	------	(1)	93. 6	97. 7
Average	15. 9	65. 2	79. 6	9. 4	72. 5	90. 9	15. 0	93. 3	97. 8	2. 9	91. 3	95. 9

[1] No checks available.

The relative value of two and three applications of bordeaux mixture for the control of cercospora spot and black spot as compared with no spray during the same period is graphically shown in figure 1. The average percentages of disease-free fruits, from sprayed and unsprayed trees during each season, as shown in table 3, have been used as a basis for the graph.

During 2 of the 4 years covered there is very little difference in the percentage of clean fruit from two and three spray applications. Two applications will generally give satisfactory control where early maturing varieties are concerned. Three applications will give more dependable control where late varieties are concerned and where black spot may become a factor late in the season.

As a result of this investigation the following schedule is recommended for the control of cercospora spot and black spot.

SPRAY SCHEDULE FOR CERCOSPORA SPOT AND BLACK SPOT

Spray	*Application*
4-4-50 bordeaux mixture	No. 1. Between May 1 and May 15. Foliage and fruits should be thoroughly covered at this time. No. 2. Should follow not later than 1 month after the first. These two applications will ordinarily give ample protection to varieties maturing in late summer and until the first of October. No. 3. If necessary, should follow 1 month after the second. For varieties maturing during the winter or early spring this third application will be advisable.

If severe cercospora spotting occurs on the leaves during August or September, especially on trees that were not sprayed during the summer, an application of 4-4-50 bordeaux mixture should be made in early March as a clean-up spray.

Care should be used in the preparation of the bordeaux mixture and also in applying it. The addition of some spreading agency such as calcium caseinate is desirable, and the fruits should be thoroughly covered for adequate protection. Where the trees are tall the use of a good spray gun and ample pressure to produce a mist spray will be of great advantage.

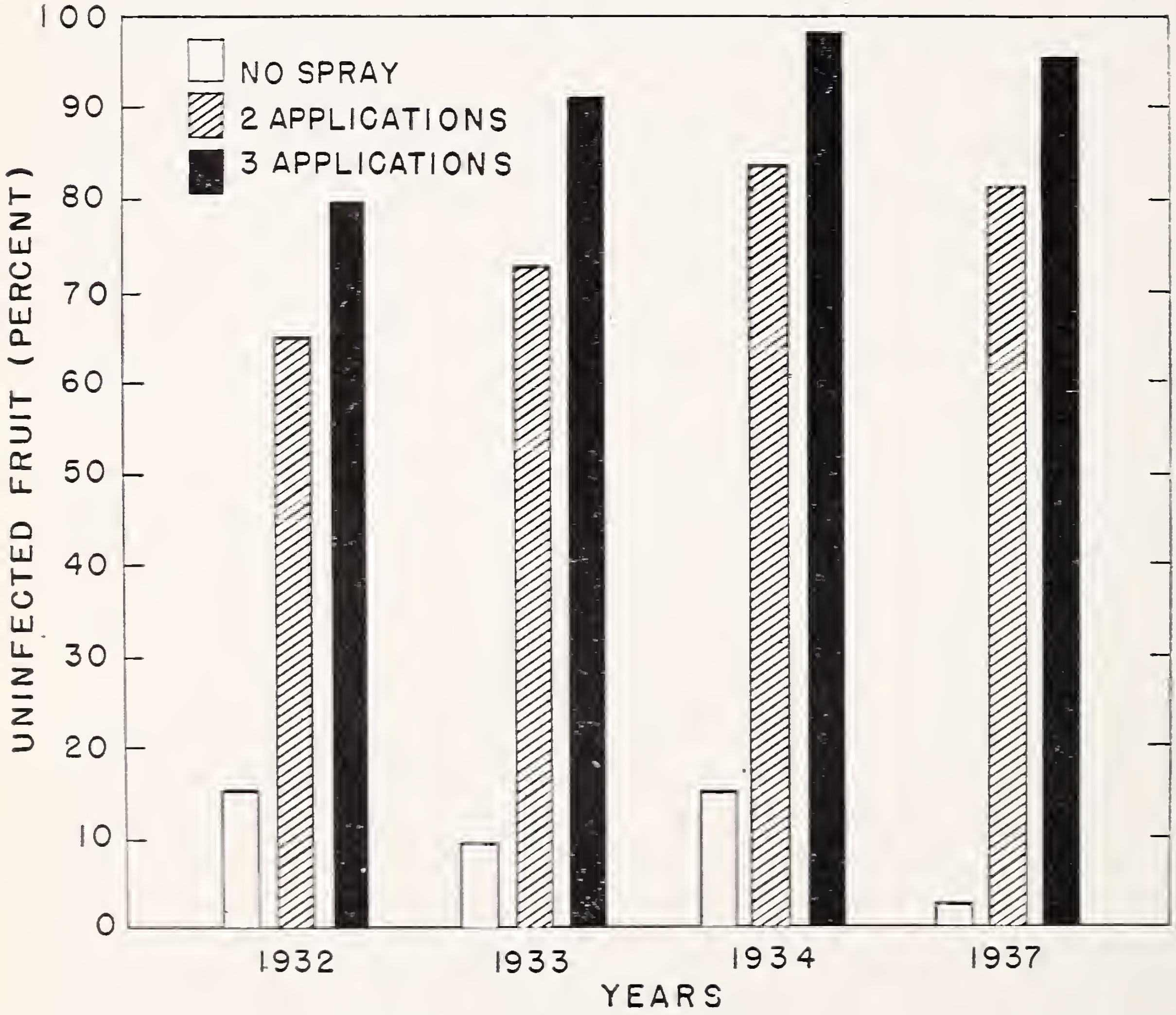


FIGURE 1.—Average percentage of avocado fruits free from cercospora spot and black spot as a result of two and three applications of bordeaux mixture applied during each season, as compared with unsprayed fruits over the same period.

BLACK SPOT OR ANTHRACNOSE ROT (COLLETOTRICHUM GLOEOSPORIOIDES) Penz.

Black spot or anthracnose rot is a typical rot of avocado fruits occurring chiefly in association with cercospora spot or with any other break in the rind of fruits that are nearing maturity. It is caused by a fungus, a species of *Colletotrichum*, which is widely distributed over the State and is responsible for fruit rots of other tropical fruits. The disease was reported in 1918 (*9*) as being troublesome on the Florida lower east coast, and it has since appeared in practically all sections of Florida where the avocado is grown.

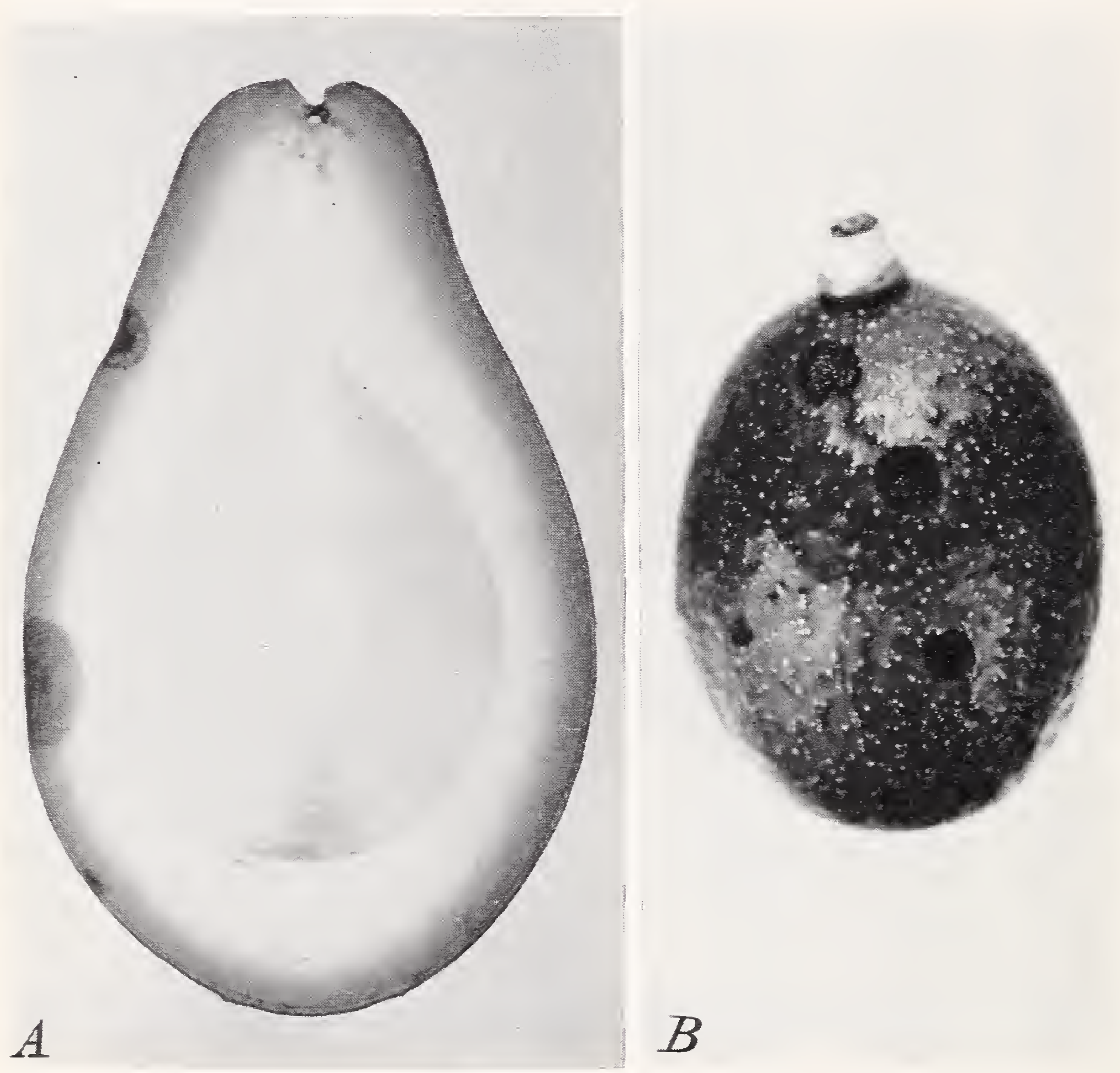
Black spot is a local name suggested by the appearance of the disease and the early usage included cercospora spot and any other similar spots that appeared on the fruits. It has been widely used and accepted by the growers as a definite type of disease, and the name black spot is here retained to apply to that form of injury appearing when *Colletotrichum gloeosporioides* Penz., causes a decay in connection with cercospora spot. It will be treated as a distinct type of disease affecting the avocado crop.

It has been definitely determined that the *Colletotrichum* fungus is a weak parasite, and that it is unable to enter the rind or establish itself in the tissue of growing fruits. It occurs only on fruits that are nearly or fully mature except in rare instances, and then some break or weakness in the rind is necessary. Black spot is merely an earlier phase of anthracnose rot, which is a characteristic type of injury caused by this fungus. Its constant association with cercospora spot on fruits has led to confusion in separating the two diseases.

Under certain conditions black spot may cause a severe loss in fruits, but ordinarily it is of secondary importance and it can easily be controlled in the field by the use of bordeaux mixture. It is more destructive to individual fruits than scab or cercospora spot, as it causes a decay that may destroy the market value of the fruit; however, its effect on the crop as a whole is less as it is not so widespread nor so abundant as either scab or cercospora in any normal season.

APPEARANCE

Black spot occurs on maturing avocado fruits chiefly in association with cercospora spot or with any break or weakening in the rind. The injury appears as definite spots scattered over the surfaces. They are mostly circular in outline, black to dark brown in color, varying from one-fourth to one-half of an inch or more in diameter (pl. 6, *B*). The centers of the spots may be slightly sunken, and in older larger spots, under moist conditions, numerous small waxy flesh-colored spore masses may be seen breaking through the epidermis. Surfaces of the larger spots frequently appear zonated, cracked, or fissured. Beneath the surface of all spots the flesh is decayed, forming a globular mass that easily separates from the healthy meat (pl. 6, *A*). This is greenish black to black, at first soft and slightly watery, but becoming firm and tough at the center as the spots increase in size. The decay rapidly extends through



Black spot of avocado fruits. *A*. Mature infected fruit cut to show penetration of the rot into the flesh of the fruit and the typical globular shape associated with this type of rot. *B*, Surface view of black spot infections. The small white dots in the centers of the spots are pink masses of conidia of *Colletotrichum*.

the flesh of the fruit down to the seed. Spots formed around older and large cercospora spots have centers of hard, dry, spongy tissue, dark brown, and cracked or fissured. These centers are usually margined with narrow black borders, gradually fading into the healthy surrounding rind tissue. The characteristic globular mass of decayed tissue develops underneath.

The black color of the spots and the decay immediately below are distinctive features of black spot.

Spots frequently develop rapidly, hastening the maturity of the fruit or causing it to drop.

CAUSE

Black spot is caused by a fungus which appears to be identical with *Colletotrichum gloeosporioides.* The causal fungus has been repeatedly isolated from typical black spot lesions on fruits and from stems, dead avocado twigs, dead areas on debilitated leaves, and the surfaces of decayed, mature fruits. Sound avocado fruits have been inoculated on various occasions with pure strains of the fungus, but typical infections resulted only when such inoculations were made through punctures into the rind of mature or nearly mature fruits. Inoculations into immature fruits did not induce infections, and inoculations on the surface of mature fruits failed to induce the disease where the rind of the fruit was unbroken. *C. gloeosporioides* is widely distributed over Florida, and it affects a large number of plants. The fungus is a weak parasite and rarely becomes destructive except to tissue of low vitality. It is of common occurrence in the citrus groves and seriously affects the mango fruit. The fungus is also saprophytic in habit and can exist and propagate readily on the dead twigs, leaves, and fruits of various plants. It is continually present in the avocado grove but rarely becomes a serious pest except as a secondary factor.

CONTROL

No special spray program will be necessary for the control of black spot where sprayings have been made to control cercospora spot. As both of these diseases are closely associated and they usually occur together, the treatment for cerospora spot will eliminate any appreciable amount of black spot. The results from experiments have shown that little or no black spot appeared on plots properly sprayed for scab and cercospora spot. If the crop is damaged late in the season by high winds or storms, an application of 4–4–50 bordeaux mixture immediately following may prevent an outbreak of black spot on the later maturing varieties.

FRUIT ROTS

After the avocado fruit has fully matured and it has been harvested and held for a time, several serious rots may appear. These usually develop rapidly after the fruit begins to soften, and affected fruits may be completely destroyed by decay in 2 or 3 days. These rots rarely appear in sufficient numbers under field conditions to excite interest, and as yet they have not been considered a serious factor in crop production. Several types of decay have been observed during the past few years, including a group of stem end rots and other rots affecting the sides or blossom ends of the fruits. These have appeared repeatedly and are distinct from the ordinary decay that usually affects fallen fruits. Fruits that drop to the ground may soon rot through the activity of several fungi and bacteria that are present in the soil, but when rot develops on fruits that have been picked from the trees and held for a time, the decay is usually the result of some organism present in or on the affected fruit during that time. In the rots under consideration, a particular fungus has been obtained in pure culture from each type of rot and has caused a similar rot when introduced into sound avocado fruits.

These fungi are all weak parasites and they are unable to affect the maturing fruit tissue until after it begins to decline or become senescent. They are widely distributed in Florida and some of them attack and cause similar rots in other tropical fruits.

ANTHRACNOSE OR RIPE ROT (COLLETOTRICHUM GLOEOSPORIOIDES) PENZ.

Anthracnose or ripe rot is the most common form of decay affecting mature avocado fruits in Florida. It is caused by the same fungus (*Colletotrichum gloeosporioides*) that produces the black spot phase of rot associated with cercospora spot earlier in the life of the fruit. The fungus is a saprophyte or weak parasite and lives mostly on dead or declining tissue. When the avocado becomes fully mature and begins to soften, an excellent medium for anthracnose development is formed. Round black spots first appear on the surface of mature fruits and rapidly expand to 1 or 2 inches in diameter. These may appear on the sides or blossom ends of fruits, starting from some injury in the rind. The decay continues through the flesh down to the seed, becoming greenish black or brown, and rancid. Surfaces of the spots become depressed and covered with the pink spore masses. The decay remains fairly firm and does not become watery. From one to several spots of this type may occur, involving most of the fruit.

On thin-rind varieties held for a long period the spots may appear as small sunken pits, brownish in color. These usually develop around the small porelike openings in the rind through which the fungus has entered. At first the decay is confined to the surface of the fruit, but soon extends inward to the seed. The spots soon merge, forming an uneven surface over the fruit on which appears a profusion of pink spore masses (pl. 7, *A* and *B*).

STEM-END ROTS

(Species of *Diplodia*, *Phomopsis*, *Dothiorella*)

The stem-end rots are typical in that the decay always begins at the stem end of the fruit and proceeds rather uniformly toward the blossom end, finally involving the entire fruit. Three such rots have been found affecting the avocado in Florida.

APPEARANCE

As these rots are very similar in general appearance in their early stage, one description will apply to all.

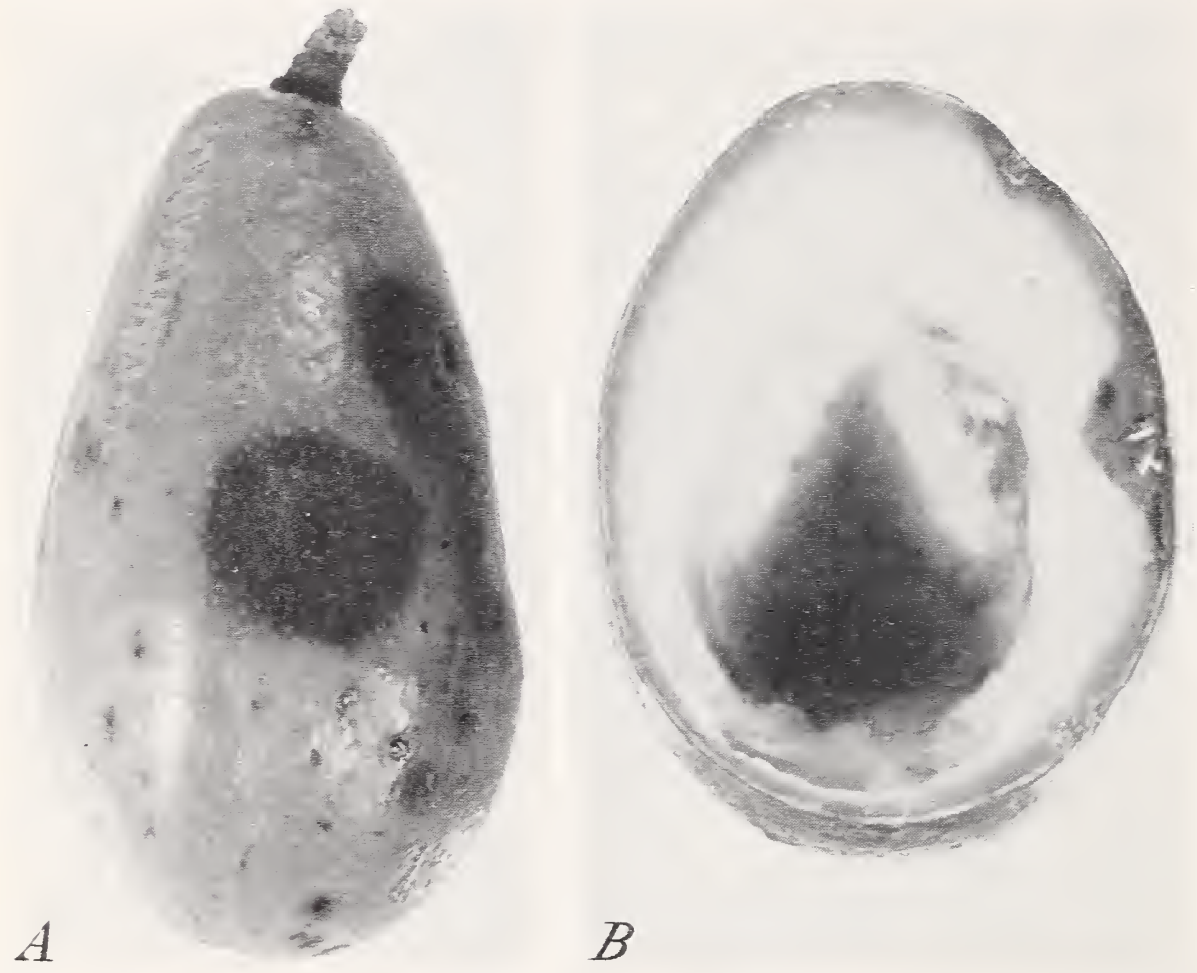
The rot begins at the stem end of the fruit as a small ring of affected tissue, dark brown in color and firm in texture, and spreads toward the blossom end more or less uniformly, finally enveloping the fruit (pl. 8). Except for discoloration very little external change is noted, and the surface remains smooth and firm. Progress of the rot may be more rapid near the rind but the flesh is rapidly invaded down to the seed, becoming dark to black, at first soft and spongy and later more or less firm. Later a surface growth of short, feltlike fungus mass appears on the fruit, varying in color and amount with the fungus causing the rot.

The most commonly observed type of avocado stem-end rot is caused by *Diplodia natalensis* Evans. This fungus is widely distributed in Florida and is the cause also of stem-end rot in citrus and mango fruits. In regard to the avocado the fungus is a weak parasite and causes no serious injury except to the mature fruits. From the production standpoint this damage is relatively small. The fungus is usually found in the dead bark of avocado trees, and it is more or less abundant in any avocado grove of bearing age.

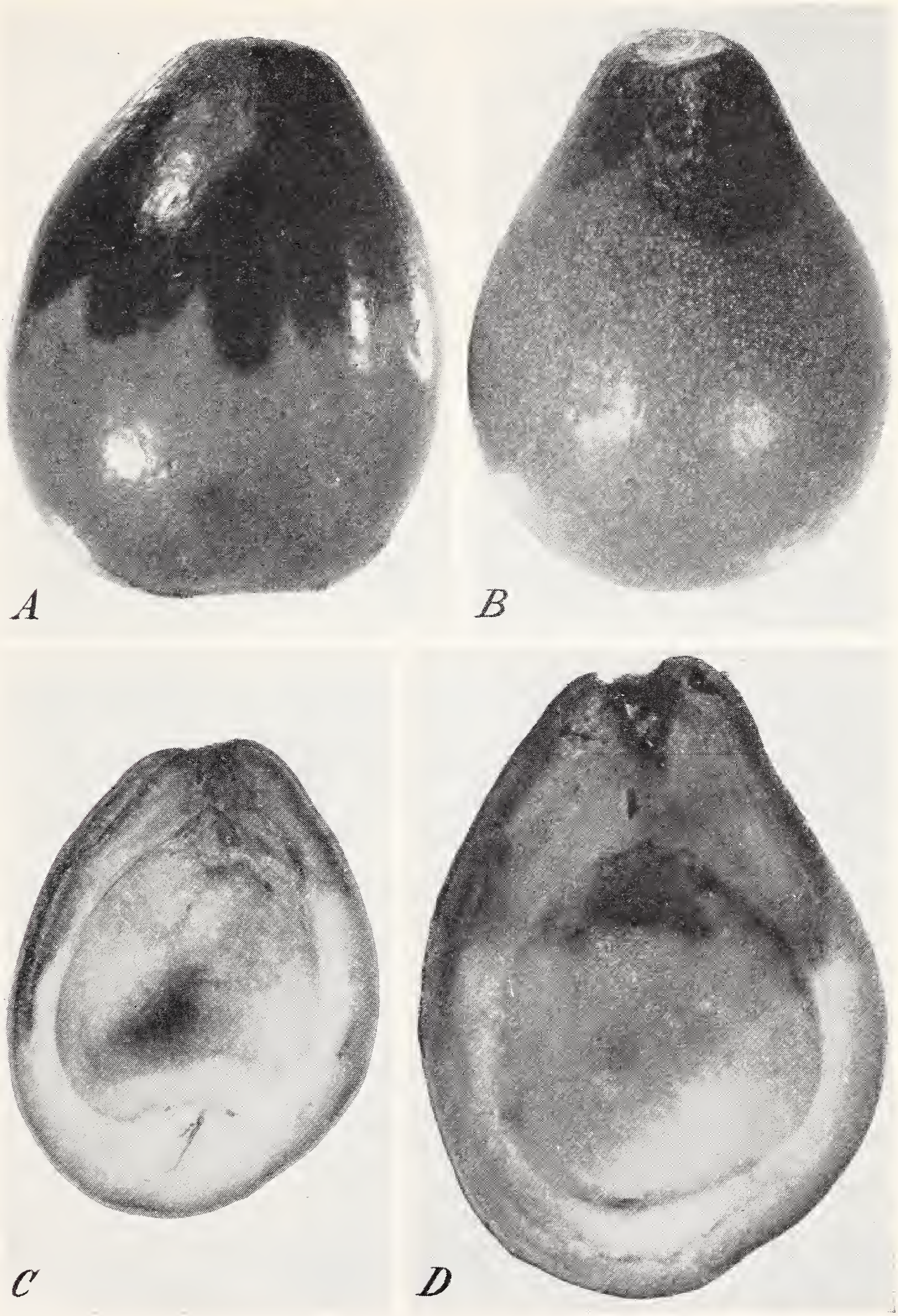
A second type of stem-end rot is also found from time to time. This is caused by a species of *Phomopsis* as yet unidentified. It is a different species from *Phomopsis citri* Fawc., and apparently does not affect citrus. What appears to be the same fungus has been isolated from a stem-end rot of mangos. The fungus has been found in the dead bark of avocado twigs in which it survives from one season to the next. It seems to be a weak parasite and only occasionally affects the mature fruits of the avocado.

A third type of stem-end rot is frequently found on avocados. This is caused by a species of *Dothiorella*, the identity of which is yet uncertain. This same fungus causes a similar stem-end rot of mango fruits, and inoculations into sound healthy oranges have resulted in a definite decay of citrus fruits. This fungus also appears to be a weak parasite, affecting only mature avocado or mango fruits. It is found in the dead bark of avocado twigs but rarely abundantly, and no effects have been noted on leaves, growing fruits, or twigs. It is of little economic importance at present in Florida avocado production. The fungus has been repeatedly isolated from avocado fruits affected with stem-end rot, and an unidentified perfect stage has been found on decayed fruits and dead twigs of avocado.

A dothiorella rot of avocados has been reported in California (*3*) as a serious trouble in certain moist localities. The illustrations and description of the disease indicate an early stage of spot development over the surface of infected mature fruits, later changing into a soft, watery, rancid rot involving the entire fruit. This type of rot has not been observed on avocados in Florida in connection with the *Dothiorella* species under study. Opportunity has not yet been available to observe the California disease or to study the fungus causing it, but the difference in symptoms of the two diseases on avocado fruits indicates they are caused by different organisms.



Anthracnose or ripe rot of mature avocado fruits. *A*, Typical anthracnose spots on the surface of a mature avocado fruit as a result of inoculations into the rind with spores of *Colletotrichum*. *B*, Cut section through an inoculated fruit showing the penetration and spread of the decay. Compare with black spot infection, plate 6, *A*.



Stem-end rots of avocado fruits. These rots may be due to *Diplodia*, *Dothiorella*, or *Phomopsis*. *A*, An advanced stage of stem-end rot, showing fingerlike projections of the decay in the rind. *B*, An early stage of the rot more uniform in its progress through the rind. Both types are the result of inoculations into the stem ends of fruits. *C*, A cut section through an advanced stage of stem-end rot showing the progress of the decay. *D*, A cut section through an earlier stage of the rot. In both *C* and *D* these rots were the result of inoculations into the stem ends of sound mature fruits.

CONTROL

In the past none of the stem-end rots of Florida avocados has been considered serious enough to warrant any special control measures. However, in the future they may become a problem in the shipping and handling of avocado fruits and may require special measures for control or elimination, possibly starting in the grove.

DISEASES OF THE BARK

Very few diseases of a serious nature have been found as yet affecting the bark of roots, stems, or branches of the avocado tree in Florida. Frequently young trees decline and die shortly after planting, and a type of decline is often noted in the larger bearing trees after several successive crops. None of these seems to be due to any specific cause of a parasitic nature, and they are probably the result of several factors involving soil, nutrition, and local environment.

One bark disease has been noted during the past few years, a collar rot of the trunk affecting certain varieties. It has not become widespread or serious, and trees that appear to be severely affected during some period of the year tend to resist the attack and recover in a short time without any special treatment.

Collar Rot (Phytophthora sp.)

Collar rot is a bark disease affecting the trunks of avocado trees near the ground. It is caused by a fungus belonging to the *Phytophthora* group, similar in its reactions and habits to *Phytophthora parasitica* Dastur which causes foot rot of citrus trees. The fungus has not been sufficiently studied for definite identification. It has been isolated from collar rot infections on avocado trees, and the infectious nature of the fungus has been demonstrated by inoculations into the bark of healthy trees. Typical infections of collar rot resulted from such inoculations. The fungus infests the soil around avocado trees where it may persist through long periods and become active under moist conditions.

APPEARANCE

Collar rot is not readily detected until it has made considerable progress in the bark. It is more active in the inner bark near the wood, and large areas of infection may appear here with no evidence of the disease on the surface (outer bark). In later stages the outer surface of the bark covering the infected area darkens, and a dark streak appears on the trunk extending from the soil upward for a few inches to 2 feet or more. These streaks are generally narrow, and the progress of the disease appears to be upward along the trunk rather than downward or laterally. Even in severe attacks the trunk is rarely completely girdled.

Patches of a powdery exudate, white to yellowish in color, are often found on the surfaces of the dark streaks and around small cracks or fissures in the bark.

If the outer bark is removed from an infected area a distinct line of demarcation is found separating the healthy and infected inner bark. The infected bark tissue is flesh-colored and frequently contains large pockets of a dark, amber-colored, gummy liquid. After the progress of the disease is arrested the infected bark tissue becomes dry and hard, and it is later pushed away by the formation of new bark from the edges of the affected area.

CONTROL

The disease has not been given sufficient study for formulation of any definite method of control. It has not been found abundantly in any particular grove, and field observations do not indicate that it spreads rapidly or causes serious loss in trees. Infected trees seem to have enough resistance under normal conditions to overcome the trouble.

Removing the soil from around the trunks and exposing the collar region for a time may be sufficient to check the disease. However, the collar and roots should not be left exposed during the winter season.

DISEASES OF MINOR IMPORTANCE

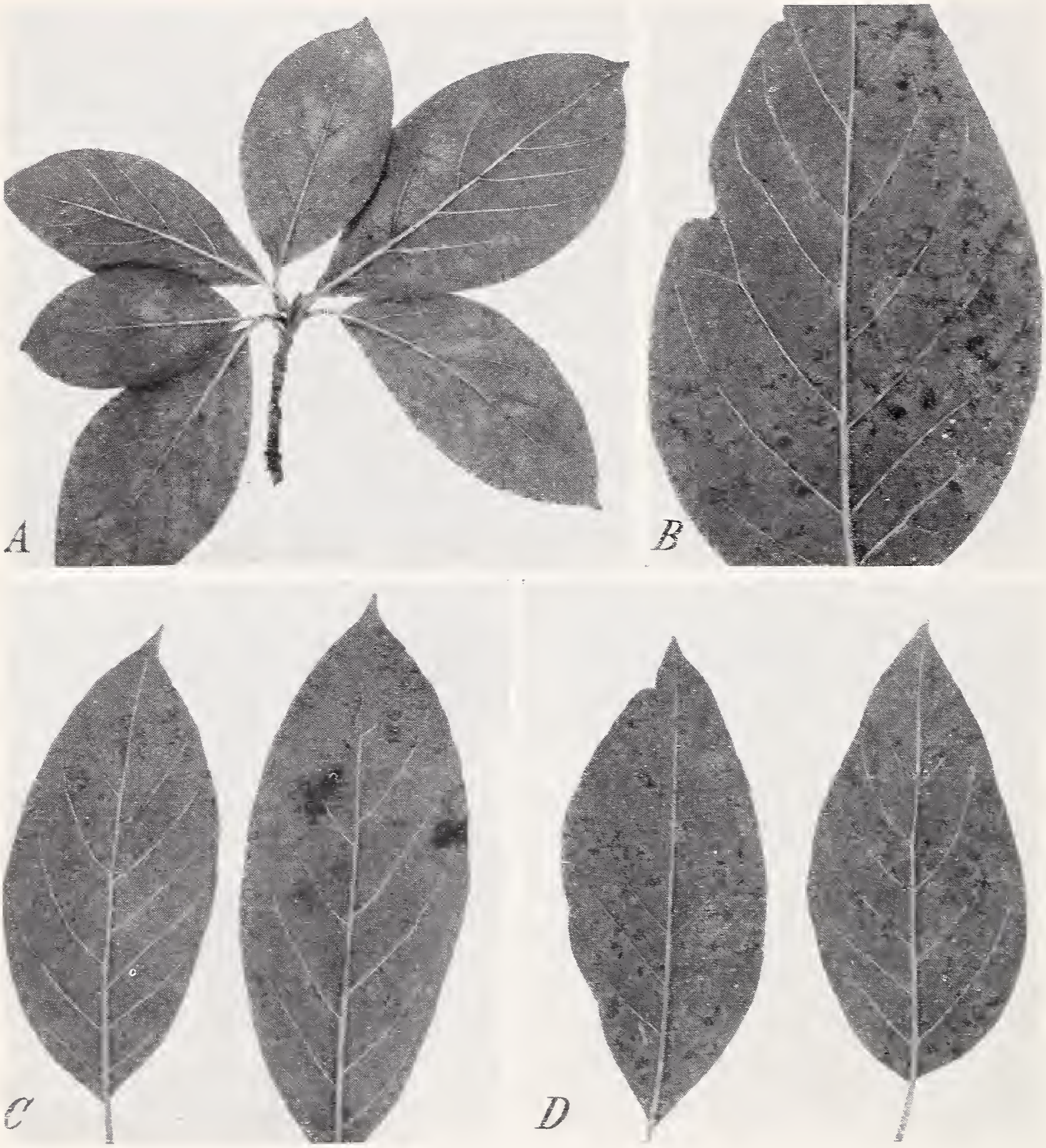
A miscellaneous collection of injuries frequently found in the avocado groves may be classed as minor diseases. These rarely become so serious as to require special or regular methods of control; however, they are often mistaken for something more serious and may cause undue concern. A few are parasitic in nature, and under special conditions may cause more or less injury. Others are of little or no importance in regard to the damage they cause. To avoid confusion and assist in identifying these troubles, the following descriptions are presented.

Powdery Mildew (Oidium sp.)

Powdery mildew is a foliage trouble frequently found on both young and old avocado trees (pl. 9). It is not serious in bearing groves but may become troublesome in nurseries or on young trees in damp, shaded locations. It is a fungus disease that may be rather easily controlled, if it becomes sufficiently abundant to cause trouble. The causal organism belongs to a group of fungi that develop a superficial, powdery growth on several crop plants, and these are controlled rather successfully by applications of sulfur, usually in the dust form.

APPEARANCE

Attacks on young nursery trees may result in the killing back of the tips of tender shoots. The affected terminal leaves may show a dark-green discoloration on the upper surfaces along the midrib, as if the tissue were water-soaked. From one-third to one-half of the leaf may be infected and become curled or dwarfed. On the under side of the leaf the same dark-green area is visible, and this is generally covered with a white powdery fungus growth, the spore-bearing parts of the fungus.



Powdery mildew on avocado leaves. *A*, A group of avocado leaves showing initial infections of powdery mildew. *B*, Undersurface of infected avocado leaf showing typical infections, irregular or reticulate in character. *C*, Infected leaves showing distinct purple discolorations found associated with infected areas. *D*, Infected leaves showing distribution of infections on the undersurfaces.

On the more mature leaf tissue, especially on bearing trees, the leaves are not curled, and the affected areas appear as more or less scattered irregular spots or blotches, varying from ½ to 1 inch or more in extent (pl. 9, *A*, *B*, *C*, and *D*). The fungus growth is confined to the under surfaces of infected leaves, and the spots are rarely conspicuous on the upper side except in a faint outline. The infected tissue has a purplish cast, and the lower surface is generally sprinkled with the white powdery fungus growth. A distinguishing feature of the disease is the network of veinlike markings on the surfaces of older spots on maturing leaves (pl. 9, *B* and *C*). On bearing trees infection is usually confined to leaves nearest the ground.

The development and spread of mildew is influenced by moisture, and it is more troublesome in damp, shady situations. Fogs, heavy dews, and continued periods of rain may cause it to become active.

CONTROL

No definite experiments have been made for the control of this disease because it has never appeared as a serious factor under grove conditions. It has not been observed affecting the bloom or fruits, and only a small percentage of foliage infection has been observed from time to time.

In nursery plantings the disease may become serious enough to warrant control. The powdery mildews as a group are very susceptible to sulfur, and the use of a sulfur spray or dust should keep this disease in check. Where an outbreak of sufficient importance to warrant control occurs in the nursery, two or three applications of lime-sulfur solution, 1 to 40, at 2-week intervals should eliminate the trouble. If sulfur dust is used it should be applied at 10-day intervals, preferably when the foliage of the plants is wet. The sulfur dust should give equally as good control as the lime-sulfur solution, and where only a small number of plants are involved it can be used to advantage.

RUSTY BLIGHT (GLOEOSPORIUM SP.)

A fungus disease called rusty blight has been troublesome in Hawaii, but typical cases of the disease have not yet come to the author's attention in any of the commercial plantings in Florida. As reported by Higgins et al. in Hawaii (*1, pp. 23–26*), the disease is found chiefly on the foliage and young branches of the trees; however, it may also attack the bloom and immature fruits. He considers a species of *Gloeosporium* as causing the trouble in Hawaii, and believes it to be identical with a *Gloeosporium* previously reported by Rolfs (*7*).

APPEARANCE

Infected leaves turn rusty-brown, and the affected parts are often marked by concentric circles of lighter color showing the progress of the fungus in the leaf tissue. The leaf may be attacked at any point, and the infection spreads rapidly until a large part of the tissue has been invaded. Badly infected leaves soon fall, and in severe attacks the trees become nearly defoliated. The fungus may pass from infected leaves into the young twigs, later killing them. Affected branches become darker in color and continue dying back, finally carrying the disease into the larger branches of the tree.

The bloom is also attacked and destroyed, and it is often through infected flowers that the disease gains entrance to the young twigs. Severe attacks of the fungus during the period of bloom and fruit setting may cause an excessive dropping or loss in young fruits.

CONTROL

The following control measures have been advised: Attacks on leaves, bloom, and fruit may be kept under control by applications of 4-4-50 bordeaux mixture, and as soon as the trouble appears an application of the spray should be made. Other applications should follow at weekly intervals until three or four sprayings are made. All dead and sickly branches should be removed to prevent further progress of the disease in the tree.

RUSSET FRUITS

Russeting of avocados is not uncommon, and varying degrees of this type of injury may be observed during any season. Such injury may result from several causes, some of which are mechanical; in other cases the injury is probably due to the work of thrips or mites on very young fruits; and certain fungi may be concerned in still other forms.

One type of russet has been observed that is rather striking, and it appears to be the effect of superficial fungus injury. In outward appearance it closely resembles the melanose injury of citrus fruits produced by *Phomopsis citri*. The rind of a severely affected avocado fruit is thickly studded with small, hard, brown, angular spots that are raised above the surrounding tissue giving the fruit a roughened surface similar to that of coarse sandpaper. The streaks, bands, and circular markings that are characteristic of citrus melanose are usually absent; however, large, brown, caked masses frequently appear with firm glazed surfaces, which finally crack or become fissured, forming small angular spots. Slight attacks may produce small spots more or less circular in outline scattered over the surface, or the spots may occur in broken and irregular lines. The injury does not penetrate deeply into the rind. The flesh of the fruit is unaffected, and no decay has been observed following this type of injury. Fruits thus affected are often misshapen and undersized, and the outward appearance is severely marred.

This form of russeting has been noted most often on the Trapp variety but not enough to cause concern. The definite cause of the injury is unknown, but its similarity to citrus melanose and mango russet, both of which are the result of fungus attacks, would suggest the possibility of a similar cause for this type of avocado russet. At present its effect on the avocado crop is of minor importance.

ALGA LEAF SPOT (CEPHALEUROS VIRESCENS) KZE.

Avocado foliage is sometimes attacked by a species of alga, *Cephaleuros virescens* Kze., which forms characteristic spots on the upper surfaces of the more mature leaves. Although injury caused by this parasite is of minor importance, it may be frequently observed on trees growing in damp, shady situations. It has not been observed on any part of the avocado plant except the leaves and usually on the mature ones nearest the ground. This same alga attacks both leaves and bark of citrus varieties, and on these hosts it sometimes causes serious injury to the bark of smaller twigs.

Algae are low forms of plant life, some of them closely related to fungi. In general, they inhabit the water, but a few are parasitic on some of the higher plants.

The disease appears on avocado leaves as small, round, definite spots, slightly raised above the surface (pl. 10, *A* and *B*). They may vary from one-eighth to one-fourth of an inch in diameter and occur scattered over the upper surface. In general, they are brown but in their early stages the surfaces are covered with short, stubby, orange-colored, hairlike structures which contain the fruiting bodies of the parasite. When newly formed the spots only affect a few layers of cells of the upper leaf surface, and they are not visible on the under side. As the spots become older the hairlike structures disappear, the surfaces become a greenish gray in color, cell tissue below is killed, and the spots are outlined on the under surface of the leaves by a circle of brown dead tissue.

Scattering spots cause slight injury to the leaves, but numerous spots may weaken the leaf and cause premature dropping. Attacks on leaves rarely cause serious damage to the tree, and control measures will seldom be necessary. If the disease should become sufficiently abundant to warrant control, one or two thorough applications of bordeaux mixture will be effective.

LICHEN SPOTS

Lichen spots also occur on avocado leaves, usually on trees located in damp, shady situations. They may occur on the bark of the trunks and larger branches, but they are not as conspicuous on the avocado trees as on citrus or certain other fruit and shade trees growing in similar situations.

The lichen spots appear on the upper surface of avocado leaves as small whitish to greenish dots, round in outline but with irregular, wavy margins (pl. 10, *C*). They are superficial, slightly raised, and appear as if pasted to the upper surface of the leaf. They vary in size from a mere dot to one-eighth of an inch or more in diameter, and they may be scattered or appear in clusters covering most of the surface of the leaf.

Lichens are low forms of plant life that are common in humid localities. They are symbiotic aggregations of fungi and algae that obtain their food material chiefly from the air.

In general the lichens are considered harmless, and those that occur on avocado leaves do little damage other than affect the outward appearance.

Control measures will rarely be necessary. However, leaves may be rid of lichen spots by spraying with some fungicide. One thorough application of bordeaux mixture will usually accomplish results. Groves that are annually sprayed for scab and fruit spots will not be troubled with lichen spots.

MECHANICAL INJURY

Mechanical injury is common on avocado fruits grown in Florida, and it may be a considerable factor in lowering the market grades of certain varieties (pl. 11). It has been observed on practically all avocados that grow in the State, but some varieties seem to be much more susceptible to this injury than others. It is unusually common on the Lula, and it is often confused with avocado scab which also seriously affects this variety. The thin-rind varieties, such as most of the members of the West Indian group, seem to be more noticeably affected by mechanical injury than others. It has been frequently observed on Cuban avocados found in the local markets, and the same type of injury has been described from California by Horne under the name of carapace spot (*2, pp. 39–42*).

The injury is caused by the immature fruit rubbing against some object, such as a limb, branch, or leaf. The area affected becomes dark, and the surface cells harden and become smooth. As the fruit continues to develop this area becomes brown in color, hard, corky, and cracks into irregular streaks or angular spots (pl. 11, *A* and *B*).

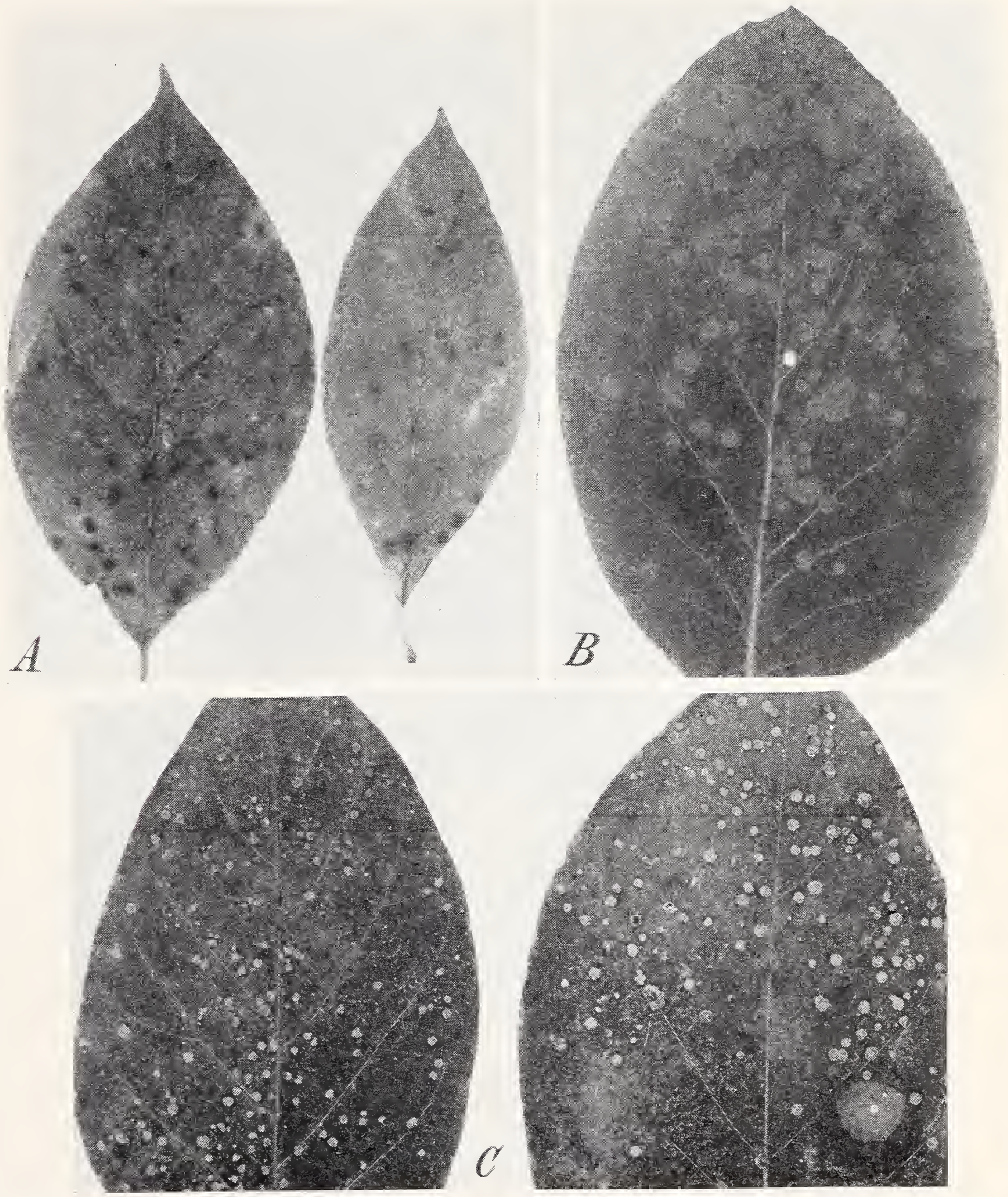
These spots do not penetrate deeply into the rind, and only a few surface layers of tissue seem to be affected. The injury persists on the mature fruit as blemishes, marring its outward appearance, but the interior or flesh of the fruit is unaffected. Severe injury on young fruits may cause them to drop or to become dwarfed and misshapen during their period of development.

The interval of time during which fruits can be affected by mechanical injury is not definitely known, but it is probably confined to their early-growing period. Very small fruits show this type of injury soon after the petals disappear (pl. 11, *C*). Fruits that are half grown or nearing maturity are apparently not affected in this same manner. Immature fruits have been observed that have passed through storms in midseason when the fruits were bruised and battered against branches, and this type of injury did not develop on the surfaces of such fruits.

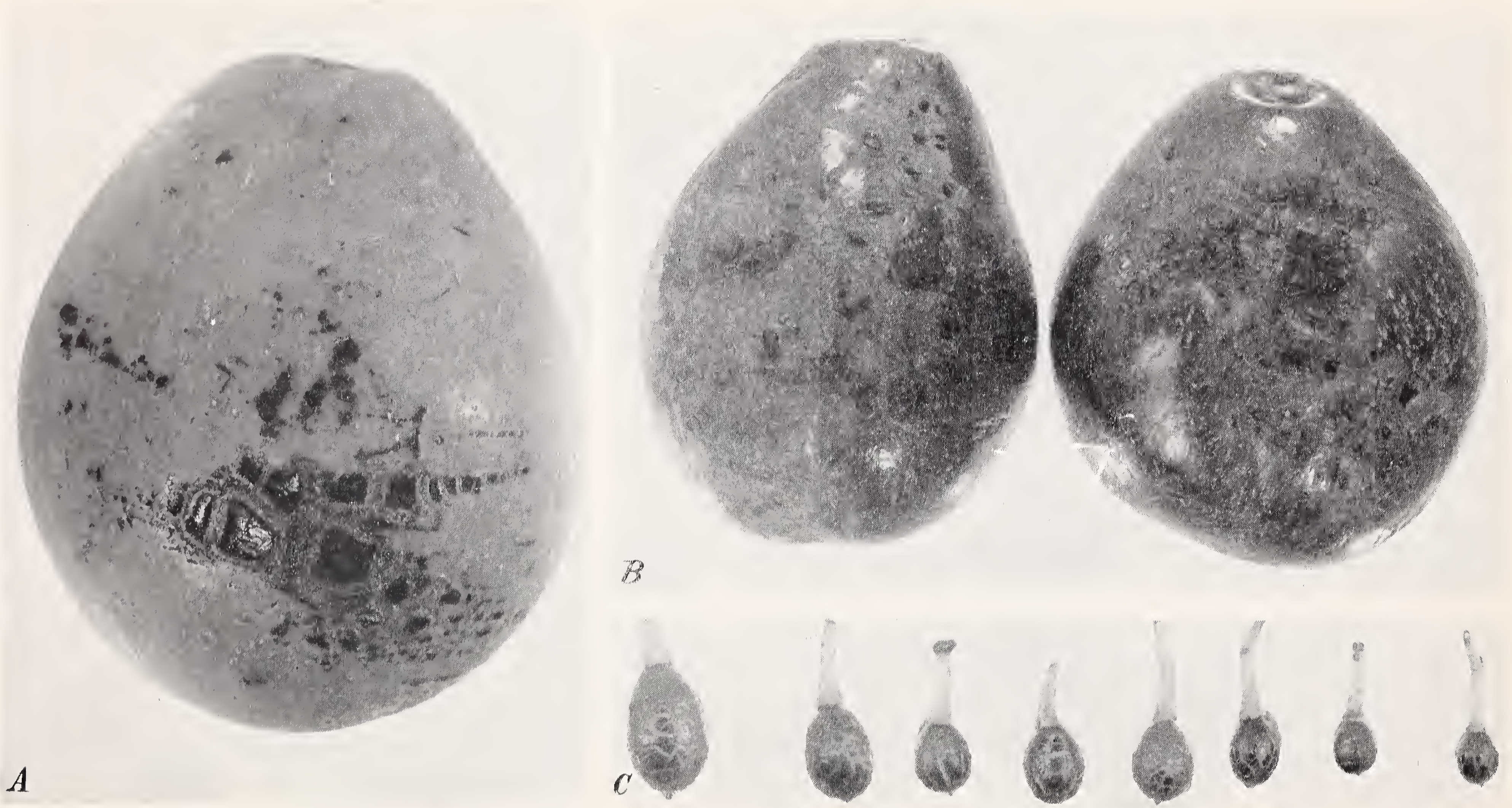
No practical method for preventing mechanical injury has yet been found. It is responsible for a considerable loss each year in lowering the grades of affected fruits. Pruning and windbreaks may be used as an aid in reducing the injury to some extent. Groves in exposed locations may develop more injured fruits than protected groves, and removal of dead and weak branches and all unnecessary growth from trees will lessen the chances for injury.

TIPBURN

Tipburn is a condition affecting the more mature leaves of the avocado tree (pl. 12). The tip and adjacent edges die back toward



Alga and lichen spots on avocado leaves. *A*, Mature avocado leaves with advanced stages of alga spots. *B*, Younger leaf showing typical alga spots of recent development. *C*, Typical lichen spots on the upper surface of avocado leaves.



Various stages of mechanical injury on avocado fruits. *A*, Typical injury on a mature avocado fruit. *B*, Severe mechanical injury on mature fruits, showing a dwarfing effect. *C*, Distinct mechanical injury on very young fruits, showing the degree and character of injury. Fruits severely affected like these soon drop or develop into undersized or misshapen forms at maturity.

the center of the leaf, forming an irregular area of dead, brown, dry tissue involving from one-fourth to one-third of the leaf area. The injury is usually confined to leaves of the same age (pl. 12, *A*), and all or the greater part of such leaves on a single tree may show the symptoms at the same time. The trouble may appear suddenly, and the affected leaves may continue to remain until their normal time for dropping. The injury is not due to any fungus or other parasitic organism; however, several different fungi may appear on the dead tissue following.

Although the cause of tipburn has not been definitely established, it is believed to be induced by conditions of moisture deficiency, which may result from a shortage of water, high salt concentration of soil solutions, drying winds, defective functioning of the root system, or general weakness of the plant. Tipburn may not follow at once a severe shortage of water but may appear some days later when an abundant supply of water is present. It has also been noted following periods of strong winds that have continued for several days.

Tipburn is rarely a serious problem in the bearing grove. Usually individual trees will show the injury rather than all the trees in a particular grove. These are probably trees weakened by other causes and they react more quickly to any set of conditions affecting the normal water supply. Young trees and those recently planted are very sensitive to tipburn, and the injury may be more or less troublesome until the trees become firmly established.

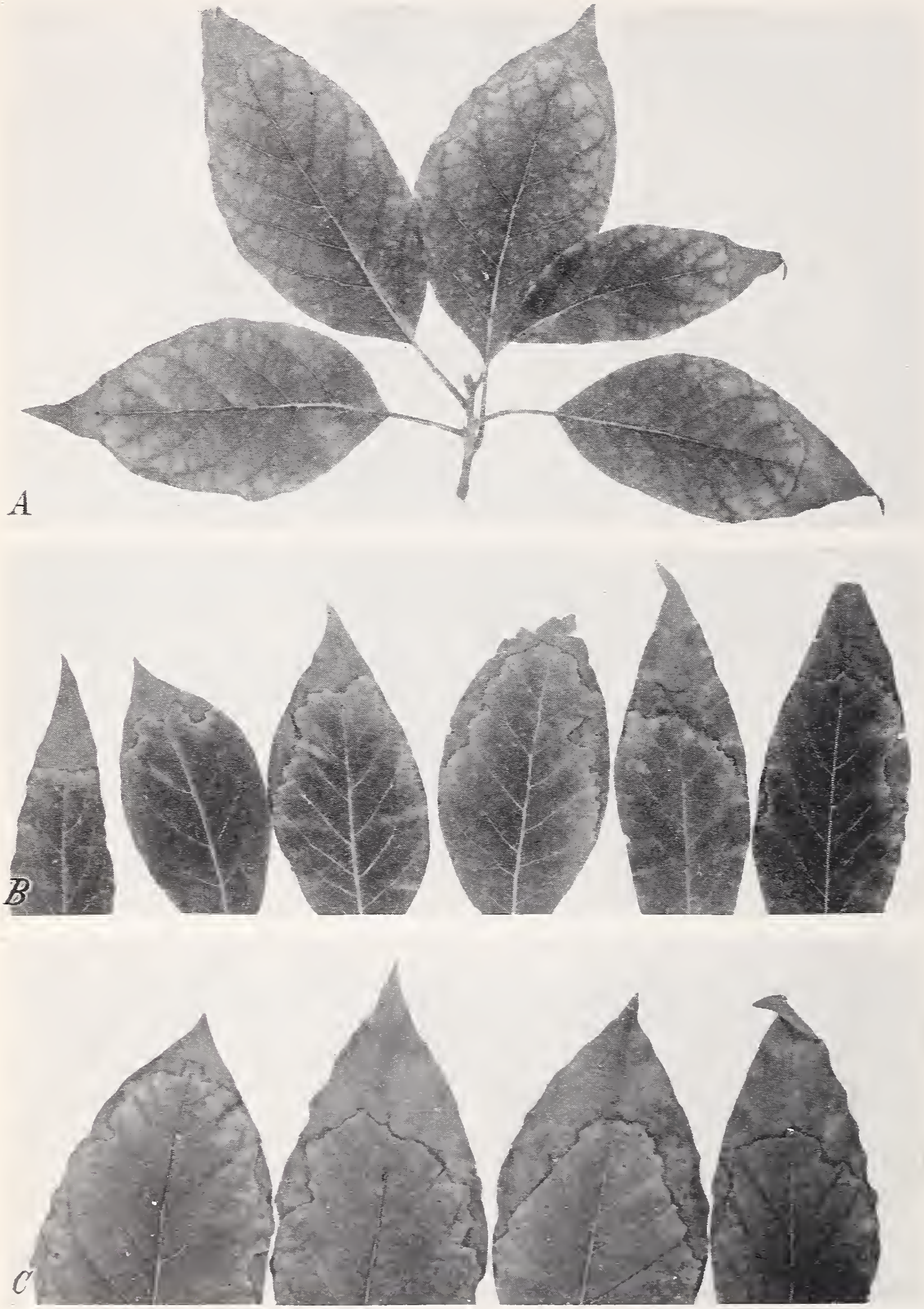
Proper methods of culture and proper nutrition to keep the tree in a vigorous state will overcome most of the tipburn likely to occur under normal conditions. In some cases there may be need of occasional irrigation or of proper drainage for soils that are excessively moist. Windbreaks may be an aid in groves subject to continued winds.

Sunscald

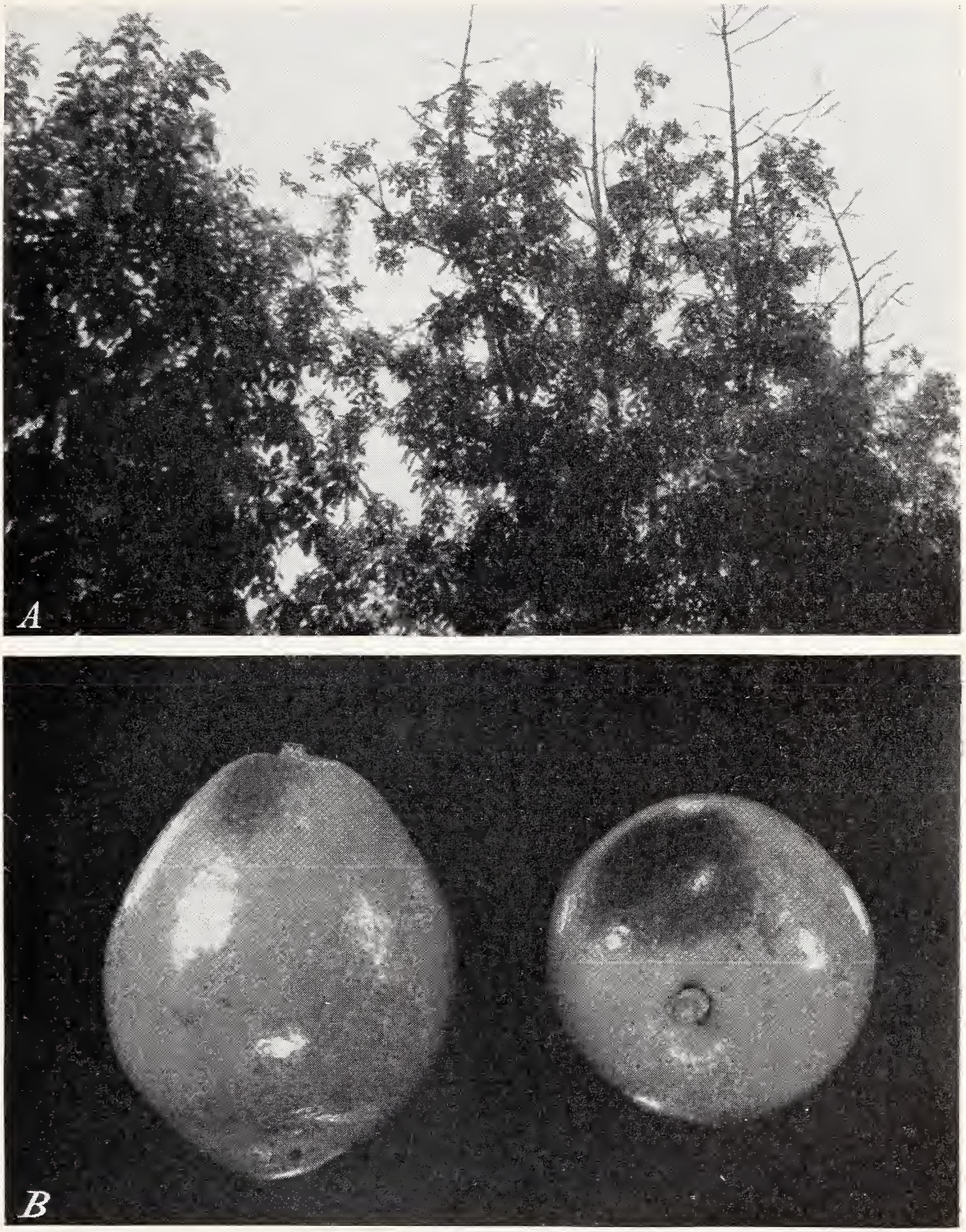
Avocado fruits, branches, and limbs are sometimes subject to severe sunscald (pl. 13). This usually occurs on trees with reduced foliage as a result of storm injury or low vitality of the tree. Such trees are usually without leaves on the top branches and have many weak and dying limbs (pl. 13, *A*).

As the fruits approach maturity, the side most exposed to the sun turns a pale-green or yellowish color and finally develops a large brown area of dead rind tissue (pl. 13, *B*). Many such fruits drop before the brown spots appear. Fruits thus exposed that reach maturity are smaller and paler than normal fruits. They are more subject to rots that affect the mature fruits than are normal fruits. Bare limbs and branches exposed to the sun develop a streak on the exposed side in which the tissue becomes dry and shrunken and finally dies. Smaller twigs die and finally drop, leaving the larger branches exposed. This condition may continue for 2 or 3 years without the tree regaining its normal vigor even though cared for in the usual way.

Weakened trees are more apt to develop sunscald, which is soon followed by a general dying back of the upper branches and limbs.



Tipburn of avocado leaves. *A*, Leaves of the same stage of growth affected with tipburn. *B*, Different stages of tipburn recently developed on fully expanded leaves. *C*, Various stages of tipburn as observed on old matured leaves.



Sunscald of the avocado trees and fruits. *A*, The effect of sunscald on limbs and branches of avocado trees; note the dead branches at the top of the affected trees and the reduced foliage of such trees. *B*, The effect of sunscald on fruits. Large brown spots on the sides exposed to the sun. Such fruits are undersized, pale in color, and may drop before fully mature.

Trees in this condition produce very little fruit, and the fruits produced are generally of low grade and quality. The Waldin, Trapp, and Wagner show a greater tendency to sunscald in open planting than some of the other varieties.

Severe pruning or cutting back of trees showing serious decline has helped to revive such trees and resulted in forming a new vigorous top at the end of the second year (*11*). In many cases drastic pruning is necessary. The main trunk is cut off 6 to 8 feet above the ground, and the limbs below this point are cut back to stubs 2 or 3 feet in length. This cutting back should be done before growth starts in the spring, and the exposed trunk and branches should be protected by a coat of whitewash or by a covering of some kind to prevent further sunscald of the bark. Large trees that are cut back in this manner will be in production again the second or third year after treatment.

SUN BLOTCH

Sun blotch affects the fruit, leaves, twigs, and limbs of the avocado, and it has been observed to occur on several different varieties. Severe attacks may dwarf the tree, distort the foliage, and reduce the fruit to culls (pls. 14, 15). Sun blotch is recognized as a troublesome problem in avocado production when it becomes established in any grove. The definite cause and mode of natural dissemination of the disease are still unknown; however, it is readily transmitted to healthy plants through budding and grafting. It was first believed to be a nutritional trouble, but more recently it has been considered to be of virus origin. The progress of the disease is usually slow, as it does not readily spread under natural conditions from one tree to another. As its dissemination is chiefly through budding and grafting, the problem of control may be greatly simplified by the isolation and elimination of diseased trees that may become factors in spreading sun blotch.

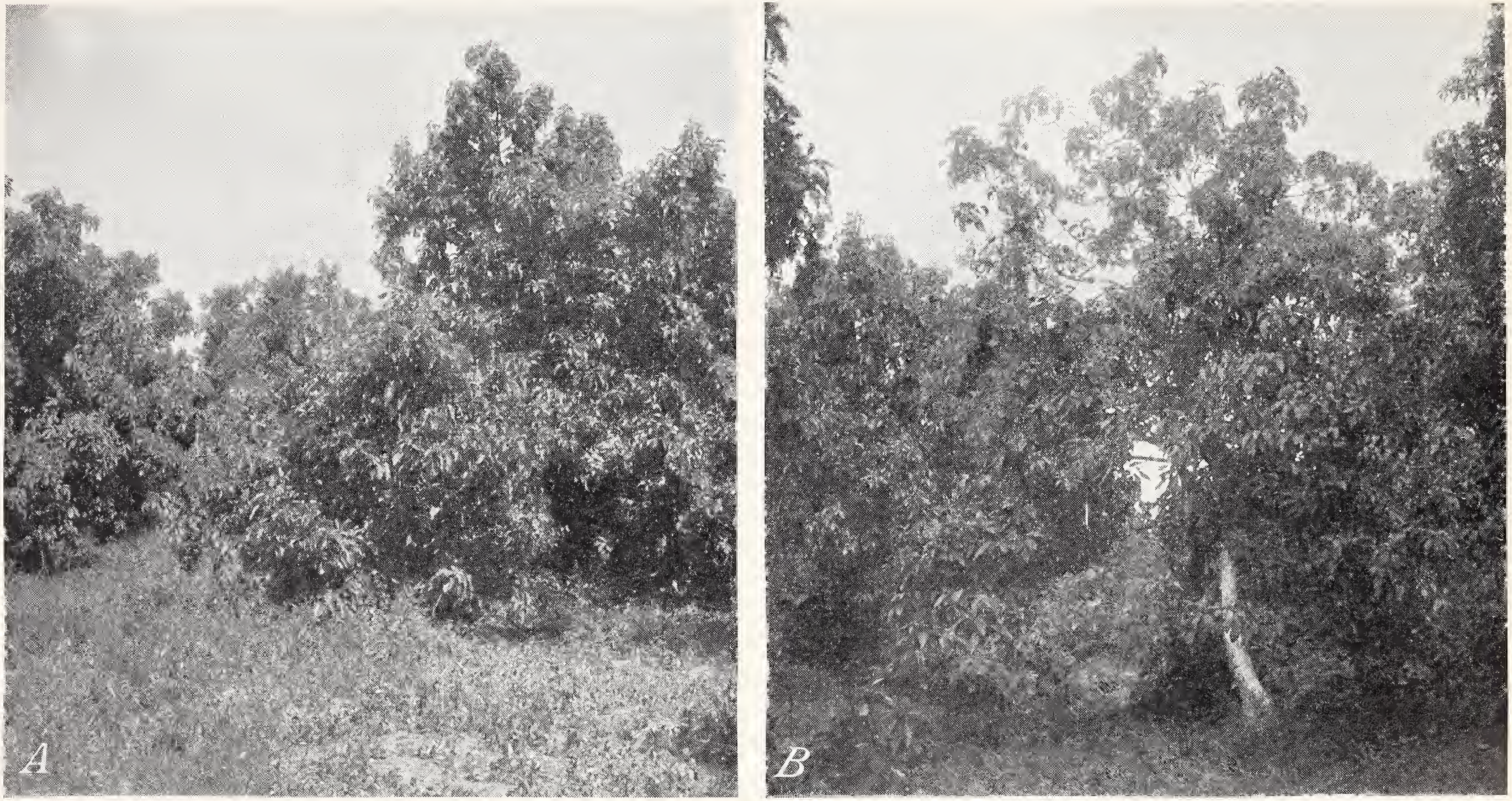
APPEARANCE

Under California conditions, Horne (*2*) describes the disease as greatly modifying the habit and shape of the tree, in addition to its localized effects on leaves, twigs, and fruits.

The affected tree appears stunted or irregular in growth. Some branches are normal; others are dwarfed and drooping, with short, slender shoots bearing clusters of leaves some of which are normal, others distorted at the base or on one edge. Infected leaves show variegated or blotched areas with white to pale-yellow tissue extending along the midribs between the veins (pl. 15, *A*). The bases of the leaves, leaf petioles, and twigs show the light- or pale-yellow color.

Affected fruits are undersized, deeply creased by white to pale-yellow depressions extending from the stem toward the blossom end (pl. 15, *B*).

Under California conditions the intensity of the disease varies greatly. Sometimes the tree is a deformed bush suggesting a weeping mulberry and bearing only cull fruits. In some cases trees have



Sun blotch affecting avocado trees. *A*, An affected tree in the foreground, dwarfed in habit of growth by sun blotch. *B*, An affected tree, showing a stunted condition of the top branches and a reduction in size and number of leaves.

good and bad shoots mingled; in others the trees are large and fine with only an occasional lightly streaked fruit.

Shoots that are vigorous and apparently normal sometimes arise from severely affected limbs, but these may later develop sun blotch shoots. Cases are reported where sun blotch shoots came up from the trunks of apparently healthy trees and where seemingly healthy trees grafted with apparently healthy scions gave sun blotch growth.

When affected scions are set in healthy trunks they give rise to sun blotch growth. Also after a time suckers arising from the stock in the vicinity of the infected scions show the disease. Healthy stocks grafted with diseased scions, but in which the scions failed to become established, have in some cases developed the disease.

DISTRIBUTION

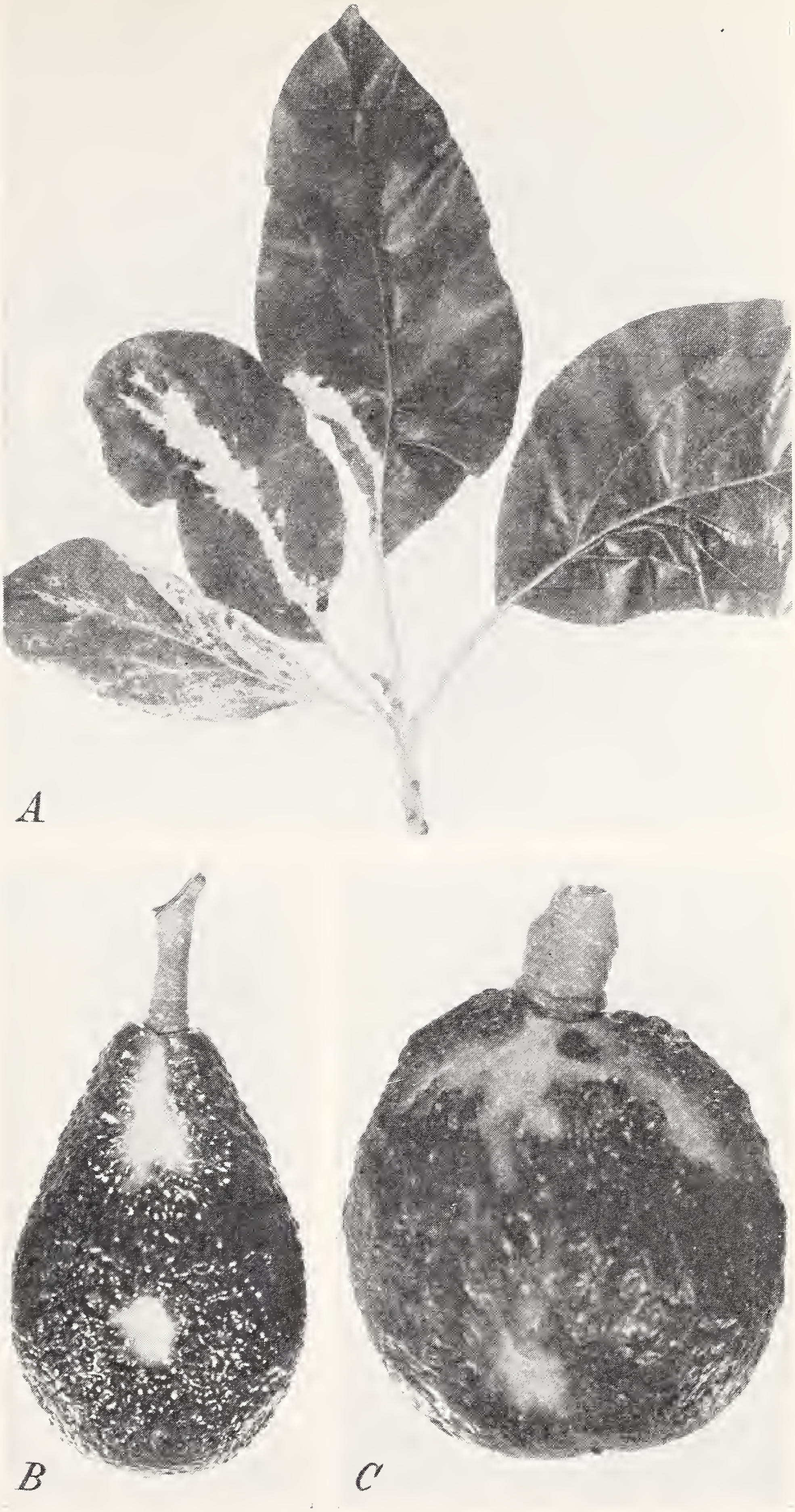
The disease is widely distributed in California, where it was first reported a number of years ago (*2*). It has also been observed in Palestine (*12*), and in July of 1938 about 30 definite cases of the disease were found in a commercial grove located near Avon Park, Fla. (*10*). In this case two varieties, the Nabal and Taylor, were visibly affected, the disease appearing only where a group of Taft trees had been top-worked to these two varieties a few years before.

Specimens of affected leaves and fruits, and photographs of affected specimens were submitted to Prof. W. T. Horne, of California, who definitely identified the disease as sun blotch, as it is known in California.

In a search of the available literature no definite reference was found to the occurrence of sun blotch in Florida other than a statement by Wolfe (*13, p. 87*) that he had seen a single case of the disease on a branch developed from a California scion. No previous report of the occurrence of the disease in Florida is to be found in the records of the Florida State Plant Board at Gainesville or of the Division of Mycology and Disease Survey, United States Department of Agriculture, Washington, D. C. The specimens found at Avon Park were the first to come to the attention of the United States Department of Agriculture during the period that avocado diseases have been under investigation in Florida.

Through inquiry and correspondence with avocado growers it was learned that sun blotch had previously been observed as early as 1932 as sporadic cases in other parts of Florida. A history of two early cases of individual trees in widely separated areas was obtained.

In one case a single tree in an avocado grove at Homestead, Fla., developed sun blotch on fruits in 1932. The tree was originally a West Indian seedling that was top-worked to Carlsbad with budwood of this variety obtained from California. The infected top was removed and the stump was grafted again with a West Indian seedling. These grafts died, and the stump was allowed to sprout and develop into a tree. No evidence of sun blotch has since appeared on the tree, and there was no apparent spread from the infected Carlsbad top to adjacent trees in the grove. The tree, however, has not fruited since the new top has developed.



Sun blotch affecting avocado leaves and fruits. *A*, The effect of sun blotch on leaves, showing a dwarfed and distorted condition of the affected leaves and the white areas of tissue between the veins. *B*, A young avocado fruit of the Taylor variety, showing the white sunken or groovelike areas on the surface, due to sun blotch. *C*, A young fruit of the Nabal variety similarly affected.

The second case involved a single tree near Rockdale, Fla., several miles distant. A Collinson scion was grafted into a Mexican stock in 1928. The origin of the Collinson scion is unknown. A severe case of sun blotch affected the leaves and fruits of this tree in 1933. The tree was later destroyed, and apparently no spread of the disease to surrounding trees has occurred.

Another case from the Homestead section was reported in 1938 on a single tree of the Lula variety. The tree was originally grafted to two varieties, Northrop and El Oro, in 1917, the scions of both varieties coming from California. The Northrop graft took the lead in growth and greatly retarded the devolopment of the El Oro branch. Later the Northrop top was destroyed in a storm, and the El Oro top continued to make a weak growth but was unproductive. In 1935 this top was cut back and the tree reworked to Lula. The Lula top has made a poor growth, but produced a few fruits during the 1938 season, two of which showed typical symptoms of sun blotch. No indications of the disease were observed on the foliage or twigs.

The appearance of sun blotch in the Avon Park section in 1938 is not easily explained, unless certain varieties of the avocado may act as hidden carriers of the disease. The history of this outbreak is interesting and unusual. West Indian seedlings were grafted (1925) with tip buds from a Taft tree growing near Lake Wales, Fla. The young trees, about 30 in number, were budded by the owner, grown under nursery conditions, and later planted in 2 rows across the grove. The trees did not prove to be satisfactory producers, and all of the Taft trees were later (1932) top-worked to Taylor and Nabal varieties. The Taylor budwood came from Taylor trees on the place, but the Nabal budwood was obtained from 2 sources in California, and it was stated to have come from trees free from sun blotch. At the time the Taft trees were worked over, seedling trees on either side of the two rows were also top-worked with some of the same budwood from California. All of the Taft trunks that had been budded to Taylor and Nabal developed more or less sun blotch this season (1938), and none of the adjacent trees or other trees in the grove that had been grafted with the same Nabal and Taylor budwood showed any indications of the disease. This would indicate that the disease was not carried in the budwood of the Nabal from California or in the local Taylor budwood, since the disease only appeared on trees that were formerly Taft buds. The owner stated that no evidence of sun blotch was visible on the Taft trees before the tops were cut back and reworked, and no evidence of the disease is visible now on scattering branches of Taft that can be found on a few of the affected trees. All the affected trees in the Avon Park grove have been removed from the soil and destroyed.

The Taft tree at Lake Wales from which the first budwood was obtained was later examined, but no visible indications of sun blotch could be found. It is a large, vigorous tree, and it has fruited rather consistently since it came into bearing. It was 1 of a group of 50 Taft trees obtained from a local nurseryman and planted 22 years ago. The rootstock is unknown, and the source of the budwood was probably California, since the Taft variety was developed in that State. The remaining Taft trees in this planting show no evidence of sun blotch; however, a majority of these show severe decline and have not produced any fruit for several years. None of the Taft trees in this grove has yet been top-worked to other varieties. It has not been possible thus far to trace the infection in the grove at Avon Park back to any definite source. If the Nabal scions from California carried the disease it would have undoubtedly appeared on some of the trees other than the Taft variety that were top-worked with the same budwood. This did not happen; but all of the Taft trees reworked to both Taylor and Nabal developed typical symptoms of sun blotch, and the only infected trees found in this planting were those top-worked on Taft trunks or else developed from scions taken later from these trees. This indicates a possible relationship between the reworked Taft trees and the later appearance of the disease. It is definitely known that an infected scion may transmit sun blotch to the stock on which it is grafted, and this stock, if later rebudded or grafted, may transmit the disease to the new top. Because no sun blotch was observed on these Taft trees before top-working, and no indications of the disease are evident at present on the original Taft tree from which the budwood was taken, it is difficult to explain the infection in this case, except on the assumption that the disease was carried in the Taft scions in a latent form.

CONTROL

Methods for the control of sun blotch are not very definite in the localities where it is prevalent. The occurrence of the disease in Florida at present seems to be very limited, and eradication would seem to be the most feasible plan to follow. All trees showing the disease should be destroyed completely, the root system as well as the top. All trees suspected of having sun blotch should be closely watched, and if typical symptoms appear the trees should be immediately destroyed.

As budding and grafting are the principal means of distributing the disease, great care should be taken in the selection of budwood from trees whose history is not definitely known.

LITERATURE CITED

(1) Higgins, J. E., Hunn, Chester J., and Holt, Valentine S.
1911. THE AVOCADO IN HAWAII. Hawaii Agr. Expt. Sta. Bul. 25, 48 pp., illus.

(2) Horne, W. T.
1934. AVOCADO DISEASES IN CALIFORNIA. Calif. Expt. Sta., Bul. 585, 72 pp., illus.

(3) ——— and Palmer, D. F.
1935. THE CONTROL OF DOTHIORELLA ROT ON AVOCADO FRUITS. Calif. Agr. Expt. Sta. Bul. 594, 16 pp., illus.

(4) Jenkins, Anna E.
1934. A SPECIES OF SPHACELOMA ON AVOCADO. Phytopathology 24: 84–85.

(5) ———
1925. THE CITRUS SCAB FUNGUS. Phytopathology 15: 99–104, illus.

(6) ———
1936. PRESENT GENERIC STATUS OF THE CITRUS-SCAB ORGANISM. Phytopathology 26: 68–70, illus.

(7) Rolfs, P. H.
1904. THE AVOCADO IN FLORIDA: ITS PROPOGATION, CULTIVATION, AND MARKETING. U. S. Dept. Agr. Bur. Plant Ind. Bul. 61, 36 pp.

(8) Stevens, H. E.
1918. AVOCADO SCAB. Fla. Agr. Expt. Sta. Press Bul. 289, [2] pp.

(9) ———
1922. AVOCADO DISEASES. Fla. Agr. Expt. Sta. Bul. 161, 23 pp., illus.

(10) ———
1939. AVOCADO SUN-BLOTCH IN FLORIDA. Phytopathology 29: 537–541, illus.

(11) Traub, Hamilton P., and Robinson, T. Ralph.
1939. EFFECT OF VARIOUS DEGREES OF HEADING BACK ON SUBSEQUENT GROWTH OF AVOCADO TREES. Fla. State Hort. Soc. Proc., pp. 43–48, illus.

(12) Schroeder, Chas. A.
1935. EFFECTS OF SUN-BLOTCH ON THE ANATOMY OF THE AVOCADO STEM. Calif. Avocado Assoc. Yearbook, pp. 125–129.

(13) Wolfe, H. S., Toy, L. R., and Stahl, Arthur L.
1934. AVOCADO PRODUCTION IN FLORIDA. Fla. Agr. Expt. Sta. Bul. 272, 96 pp., illus.

ORGANIZATION OF THE UNITED STATES DEPARTMENT OF AGRICULTURE WHEN THIS PUBLICATION WAS LAST PRINTED

Secretary of Agriculture	CLAUDE R. WICKARD.
Under Secretary	PAUL H. APPLEBY.
Assistant Secretary	GROVER B. HILL.
Director of Information	MORSE SALISBURY.
Director of Extension Work	M. L. WILSON.
Director of Finance	W. A. JUMP.
Director of Personnel	ROY F. HENDRICKSON.
Director of Research	JAMES T. JARDINE.
Director of Marketing	MILO R. PERKINS.
Solicitor	MASTIN G. WHITE.
Land Use Coordinator	M. S. EISENHOWER.
Office of Plant and Operations	ARTHUR B. THATCHER, *Chief.*
Office of C. C. C. Activities	FRED W. MORRELL, *Chief.*
Office of Experiment Stations	JAMES T. JARDINE, *Chief.*
Office of Foreign Agricultural Relations	LESLIE A. WHEELER, *Director.*
Agricultural Adjustment Administration	R. M. EVANS, *Administrator.*
Bureau of Agricultural Chemistry and Engineering.	HENRY G. KNIGHT, *Chief.*
Bureau of Agricultural Economics	H. R. TOLLEY, *Chief.*
Agricultural Marketing Service	C. W. KITCHEN, *Chief.*
Bureau of Animal Industry	JOHN R. MOHLER, *Chief.*
Commodity Credit Corporation	CARL B. ROBBINS, *President.*
Commodity Exchange Administration	JOSEPH M. MEHL, *Chief.*
Bureau of Dairy Industry	O. E. REED, *Chief.*
Bureau of Entomology and Plant Quarantine	LEE A. STRONG, *Chief.*
Farm Credit Administration	A. G. BLACK, *Governor.*
Farm Security Administration	C. B. BALDWIN, *Administrator.*
Federal Crop Insurance Corporation	LEROY K. SMITH, *Manager.*
Forest Service	EARLE H. CLAPP, *Acting Chief.*
Bureau of Home Economics	LOUISE STANLEY, *Chief.*
Library	RALPH R. SHAW, *Librarian.*
Bureau of Plant Industry	E. C. AUCHTER, *Chief.*
Rural Electrification Administration	HARRY SLATTERY, *Administrator.*
Soil Conservation Service	H. H. BENNETT, *Chief.*
Surplus Marketing Administration	MILO R. PERKINS, *Administrator.*

This circular is a contribution from

Bureau of Plant Industry	E. C. AUCHTER, *Chief.*
Division of Fruit and Vegetable Crops and Diseases.	H. P. GOULD, *Principal Horticulturist, in Charge.*

U. S. GOVERNMENT PRINTING OFFICE: 1941

For sale by the Superintendent of Documents, Washington, D. C. - - - - - - - - - - Price 10 cents